ARQ 16 FALL 1998

THE JOURNAL OF THE DEFENSE ACQUISITION UNIVERSITY

ACQUISITION Review QUARTERLY

VOL. 5 NO. 4

The ***Acquisition Review Quarterly*** is published quarterly for the Defense Acquisition University by the Defense Systems Management College Press, 9820 Belvoir Road, Suite 3, Fort Belvoir, VA 22060-5565. Periodicals Postage Paid at Fort Belvoir, VA and at additional mailing offices. Postmaster send changes of address to: Editor, ***Acquisition Review Quarterly***, Defense Systems Management College Press, 9820 Belvoir Road, Suite 3, Fort Belvoir, VA 22060-5565. For free copies, submit written requests to the above address. Articles represent the views of the authors and do not necessarily reflect the opinion of the Defense Acquisition University or the Department of Defense. ISSN 1087-3112.

The ***ARQ*** is available electronically on the DSMC Home Page at **http://www.dsmc.dsm.mil**

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
Fall 1998

3. REPORT TYPE AND DATES COVERED
Refereed Journal

4. TITLE AND SUBTITLE
Acquisition Review Quarterly (ARQ)
Vol. 5, No. 4

5. FUNDING NUMBERS

6. AUTHOR(S)
Numerous Authors

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Defense Systems Management College
Attn DSMC Press
9820 Belvoir Road
Ft. Belvoir VA 22060-5565

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Acquisition University
2001 N Beauregard Street
Alexandria VA 22311

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The primary goal of the Acquisition Review Quarterly (ARQ) is to provide practicing acquisition professionals with relevant management tools and information based on recent advances in policy, management theory, and research. The ARQ addresses the needs of professionals across the full spectrum of defense acquisition, and is intended to serve as a mechanism for fostering and disseninating scholarly research on acqusition issues, for exchanging opinions, for communicating policy decisions, and for maintaining a high level of awareness regarding acquisition management philosophies.

14. SUBJECT TERMS
Developing Curricula; Earned Value Management Process; International Cooperative Acquisitions; Managing DoD Research and Development Portfolios.

15. NUMBER OF PAGES
70

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

ACQUISITION Review QUARTERLY

Fall 1998
Vol. 5, No. 4

TABLE OF CONTENTS

Opinion

AN APPROACH FOR EFFICIENTLY MANAGING DOD RESEARCH AND DEVELOPMENT PORTFOLIOS

Drs. Carolyn Wong, Paul Steinberg, Kenneth Horn, and Elliot Axelband

Managing Department of Defense (DoD) research and development (R&D) portfolios is a challenging task today. Not only do defense R&D managers have limited resources to spend on pursuing new technologies, but there is also an active civil and commercial market for some technologies the DoD is interested in. How can the DoD better understand what areas it must pursue on its own and what areas it might be better off collaborating with non-DoD organizations? This article presents a straightforward approach for managing DoD R&D portfolios that can help DoD managers understand how their R&D efforts are allocated, and how they might more efficiently manage them to take advantage of scarce resources and technological capabilities elsewhere. After describing the approach, the authors illustrate it using the example of the basic research technologies part of the U.S. Army's R&D portfolio.

To maintain its technological edge, the Department of Defense (DoD), through its Armed Services and agencies, spent nearly $9.3 billion in fiscal year 1995 on basic, exploratory development, and advanced development research. While in the past, the DoD accepted such research and development (R&D) investments simply as necessary expenditures, today, the DoD faces a series of demands and constraints that argue for more carefully and more efficiently managing that investment: These include:

- future reductions in science and technology (S&T) funding—reductions that have averaged 15 percent per year over the past few years;
- commercial domination of many of the important technological areas for the DoD, such as information technologies;
- growth in international technology capabilities and in competition from European and Japanese companies; and

- a changing research climate within the government, with a growing ideological shift away from big government involvement in R&D.

One of the constraints affecting DoD research investments is clearly resources: Resources to conduct DoD R&D are simply more limited than they were in the past. But even if the DoD had unlimited resources with which to pursue its R&D projects, it is not always clear that the DoD is in the best position to lead in certain technological areas. There is a very active civil and commercial market, both domestic and international, that is pursuing its own R&D activities in the same areas as is the DoD, and in many situations, the commercial and civil sectors are technologically ahead.

Take, for example, global positioning system (GPS) technology. GPS began as an Air Force program to put up satellites to generate radio navigation signals to enhance the navigational capability of military vehicles and guided weapons. The DoD R&D effort in GPS technology spanned decades and consumed billions of defense dollars. Technical advances by the DoD ultimately led to recognition of commercial applications and to DoD's decision to provide a commercially available channel in addition to the secure military one. During the development of GPS technology, advances in semiconductor technology enabled small receivers to be built, and the market for geographic information systems grew rapidly. These changes led to a significant commercial R&D investment in GPS technology.

The end result is that the commercial sector now spends more than the DoD in a technological area that the DoD pioneered and once led. In terms of R&D projects, the DoD now has the opportunity to collaborate with commercial firms in areas of common GPS interest (e.g., the ground-based segment of GPS), thus reducing DoD's need to develop technology available from commercial sources.

Of course, not all technological areas are like GPS technology. For example, R&D in high-energy lasers and radiation-tolerant semiconductors for ballistic missile defense spacecraft are DoD-driven and unlikely to change, since purely commercial firms have little interest in pursuing research in these areas.

Carolyn Wong is currently an operations research specialist at RAND. She holds a Ph.D. degree in electrical engineering (operations research), an M.S. degree in management, and a B.A. degree in mathematics, all from the University of California at Los Angeles.

Paul Steinberg is currently a communications analyst at RAND. He holds a Ph.D. degree in English from the University of California at Berkeley.

Kenneth Horn is currently director of the Force Development and Technology Program in the RAND Arroyo Center. He holds a Ph.D. degree in aeronautics and astronautics from Stanford University, and M.S. and B.A. degrees in mechanical engineering from Rice University.

Elliot Axelband is currently a RAND consultant and associate dean at the School of Engineering, University of Southern California. He holds a Ph.D. degree in engineering from the University of California at Los Angeles.

How can the DoD manage its massive portfolio of R&D projects in a way that enables it to understand what areas it must pursue on its own? And in what areas might it be better off collaborating with commercial firms and leveraging off their capabilities? Here we present an approach for managing DoD R&D portfolios that can help DoD managers understand how their R&D efforts are allocated and how they might more efficiently manage them to take advantage of scarce resources and technological capabilities elsewhere. After describing the approach, we illustrate it using the example of the U.S. Army's R&D portfolio, looking particularly at its basic research technologies.

THE DOD R&D ASSESSMENT MATRIX: A TOOL FOR MANAGING R&D PROJECTS

In thinking about a useful way to help DoD research managers categorize varying projects within an R&D portfolio and manage them effectively, we developed an approach that involves using a two-dimensional matrix that is partitioned into four management domains (Saunders et al., 1995; Wong, 1998).[1] This matrix is designed to serve as a tool to obtain a first-order indication of which defense technologies might overlap with commercial technologies.[2] Below, we discuss the two dimensions and the four management domains in more detail.

MATRIX DIMENSIONS

Two dimensions are critical to categorizing any DoD R&D technology area: the technology's utility to a military Service or DoD agency, and, since many DoD technologies are being pursued by commercial firms, the technology's market breadth.

The Service or DoD agency utility dimension reflects the potential contribution of the technology to helping the Service or DoD agency accomplish its mission. In our framework, Service or DoD agency utility is represented as a continuous scale that ranges from low to high. An example of a technology that would have low Service or DoD agency utility is one that is not expected to contribute directly to maintaining DoD's future defense capability. On the other hand, a technology that is critical to conducting future defense operations is an example of a high Service or DoD agency utility technology.[3]

"The market breadth dimension is designed to indicate the level of interest outside DoD in a particular technology."

The market breadth dimension is designed to indicate the level of interest outside DoD in a particular technology. If a technology has many potential government and commercial uses (i.e., everybody wants it), then industry's interest is likely to be higher than if the technology had potential use only for a particular military Service or DoD agency (Service- or DoD agency-unique). Industry's interest in the former case is likely to be higher, since advances in the technology have potential uses in many products or services. Hence, industry is likely to perceive such a technology as one that is more likely to result in higher profits. In our framework, market breadth is represented as a continuous scale that ranges from a technology having potential uses to a particular

military Service or DoD agency only (Service- or DoD agency-unique), to potential government uses only, to potential government and commercial uses (generic).

Defining Management Domains

Technologies that have a moderate to high utility rating will fall into the upper half of the matrix framework. These technologies are generally vital to the successful completion of a Service or DoD agency's mission. The Service or DoD agency will most likely want to be active and maintain some control (e.g., through funding) over the R&D activities that occur in these technologies. At the same time, technologies whose market breadth is limited to the government will fall into the left-hand side of the matrix. The government is less likely to find suitable industrial partners in these technologies because commercial interest is limited. Hence, government funding is likely to be required for R&D to occur in technologies that fall roughly in the region called the lead domain in Figure 1.

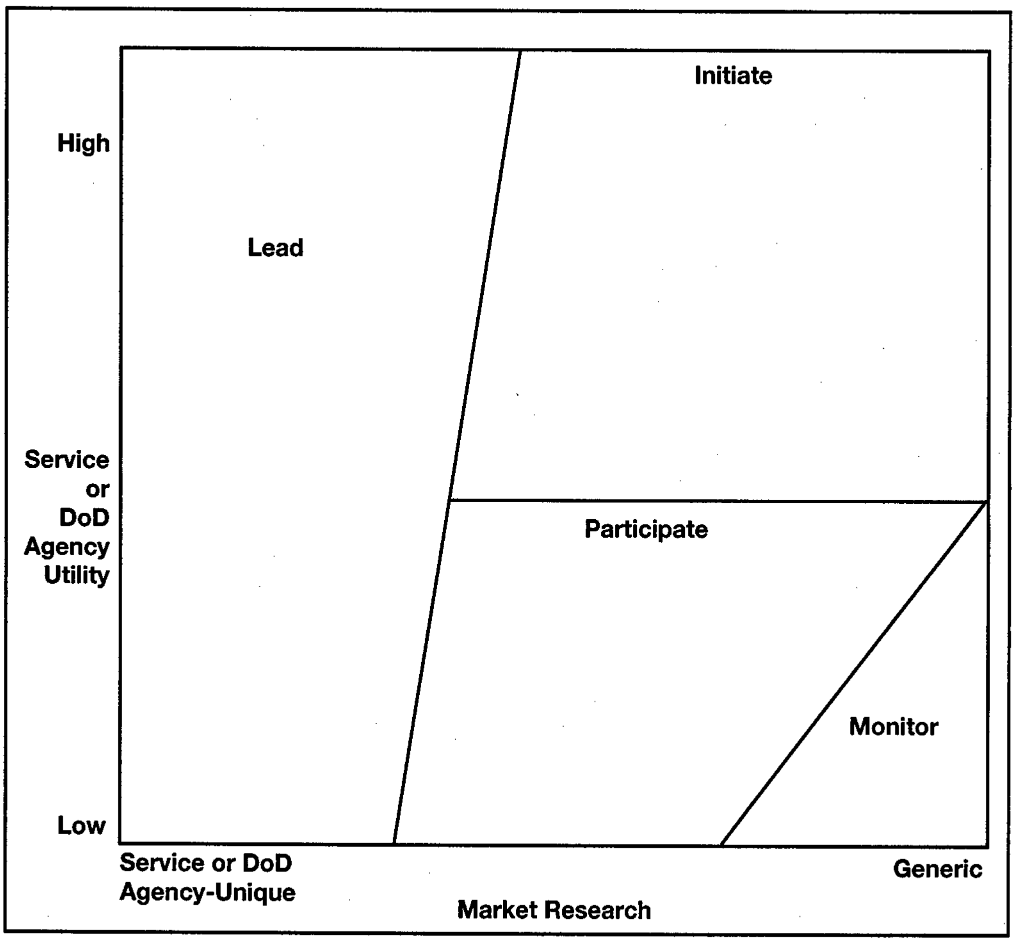


Figure 1. Management Domains Within Assessment Matrix

Since industry interest is required for collaboration to be successful, the right-hand region of the matrix framework, where industry interest is moderate to high, is the general area where collaboration is likely to work. Under tight fiscal constraints, however, a Service or DoD agency may find that it must dramatically lower or eliminate its R&D funding in some technologies. We argue that the candidates for reduced funding are those with low Service or DoD agency utility—that is, those in the lower half of the framework. Among those with low utility, those with high industry interest (i.e., technologies in the right-hand side of the framework) may be better candidates for lowered funding because R&D is more likely to be continued in those technologies through industry funding. R&D activities are unlikely to continue in Service- or DoD agency-unique technologies without government funding. Hence, technologies that are the best candidates for reduced funding fall roughly in the region called the monitor domain in Figure 1.

The remaining area on the framework in Figure 1 is divided into two domains: initiate and participate. Technologies that fall into the initiate domain have higher utility; hence, the government may want to spend more funds and effort to ensure that research in these technologies accomplishes government goals. Technologies that fall into the participate domain have lower utility; as a result, the government may be more willing to compromise on a set of goals in exchange for the benefits a collaborative effort would bring.

The Services and DoD agencies have traditionally judged the progress and success of R&D efforts in terms of three benchmarks—performance, schedule, and cost and budget[4] characteristics. As Figure 1 shows, our framework comprises four management domains, which reflect different approaches to managing the three benchmarks.[5] Our discussion below is presented from DoD's viewpoint.

Lead Domain

For those technologies in the lead domain, the Service or DoD agency should expect to spend its own funds to realize the benefits of technological advances.[6] When a Service or DoD agency chooses to lead, it defines the performance goals, provides the vision, and specifies the potential products or capabilities. The Service or DoD agency also sets forth its schedule requirements and sets the resource (cost and budget) constraints. Under a Service- or DoD agency-lead management approach, the DoD group uses contractual measures to control performance, schedule, and use of resources (budget). In the lead role, the DoD group is conducting "business as usual," and the contracted activities are usually not collaborative.

"For those technologies in the lead domain, the Service or DoD agency should expect to spend its own funds to realize the benefits of technological advances."

Initiate Domain

Technologies that fall into the initiate domain have high DoD agency or military Service utility and high industry interest. Although industry might be funding R&D in these technologies, the DoD might not wish to just stand by and rely totally on industry to meet DoD goals.

Instead, a Service or DoD agency may want to actively seek and initiate collaborative R&D efforts to ensure that R&D in these areas addresses its goals.

When a Service or DoD agency chooses to initiate, it defines its performance goals, provides its vision, and specifies products and capabilities of DoD interest. The Service or DoD agency may also set forth its schedule requirements and set its resource (cost and budget) constraints.

In its search for a collaborating partner in industry, the Service or DoD agency may look for areas of intersection among its performance goals and those of potential industrial partners, rather than negotiate a set of goals, since these technologies are primarily of high Service or DoD agency utility. The DoD group may also look for compatible schedules or negotiate an acceptable schedule and may also negotiate a set of resource constraints. Under a DoD-initiate management approach, the Service or DoD agency tries to control performance, but may share control of schedule and use of resources. In the initiate role, the DoD group is collaborating with industry. In such an effort, it should achieve the same or nearly all the same goals it would achieve if it conducted the activity without collaboration.

"Under a DoD-initiate management approach, the Service or DoD agency tries to control performance, but may share control of schedule and use of resources."

Participate Domain

Technologies in the participate domain have moderate market breadth and moderate Service or DoD agency utility. Under tight fiscal constraints, neither the Service, DoD agency, nor industry will have enough funds to invest much in these technologies. Collaboration may allow the Service or DoD agency and industry to pool resources to perform R&D in these areas. However, the Service or DoD agency may not want to expend additional efforts to actively seek and initiate research activities. For technologies in this domain, both the Service or DoD agency and industry can design and participate in activities for mutual benefit. Such efforts may require both the DoD group and industry to compromise on a set of R&D goals. Without a willingness to adjust goals, a joint investment may not be attractive enough to the Service or DoD agency or potential industry partners.

When a Service or DoD agency chooses to participate, it may negotiate acceptable performance goals if it cannot find an appropriate intersection with industry performance goals. The Service or DoD agency may also negotiate an acceptable schedule as well as a set of resource constraints. Under a DoD-participate management approach, the Service or DoD agency has shared control of performance, schedule, and use of resources. In the participate role, the Service or DoD agency is collaborating with industry and should achieve at least some of the same goals it would achieve if it conducted the activity without collaboration.

Monitor Domain

Technologies in the monitor domain have low Service or DoD agency utility (i.e., do not contribute directly or very much to its overall mission) and high market breadth. Under tight fiscal constraints, the Service or DoD agency may have to

Table 1. Benchmark Characteristics of Management Domains

Management Domain	Characteristics • Performance • Schedule • Resources	Effects • Control • Collaboration
Lead	• Define performance goals, vision, products, capabilities • Set schedule • Set resource constraints (e.g., budget)	• Service/DoD agency has full control and responsibility for performance, schedule, and use of resources (e.g., budget) • Usually not collaborative
Initiative	• Define performance goals, vision, products, capabilities • Set or negotiate acceptable schedule • Set or negotiate resource constraints (e.g., budget)	• Service/DoD agency controls performance, but shares control of schedule and sometimes resources (e.g., budget) • Can be collaborative
Participate	• Define key performance requirements and negotiate performance goals • Negotiate acceptable schedule • Negotiate resource constraints (e.g., Army's share of budget)	• Service/DoD agency shares control of performance, schedule, and resources • Should be collaborative
Monitor	• Vigilant communication of performance requirements • Communication of schedule requirements • Little or no resource commitments	• Service/DoD agency has no control of performance, schedule of resources • Service/DoD agency does not have a formal role

let industry take the lead for technologies in the monitor domain and limit its own R&D investment there, restricting its role to one of active monitoring. Active monitoring could include low or no-cost activities, such as establishing working relationships with industry leaders, regularly (but informally) communicating DoD needs in the technology, and attending workshops and conferences. In the monitor role, the Service or DoD agency does not have a formal role and has no control over performance, schedule, or use of resources committed to R&D activities.

Table 1 summarizes typical performance, schedule, and cost benchmark characteristics and control and collaboration effects of the four management approaches in the matrix. As noted earlier, the demarcations between the management approaches are fuzzy.

Applying the Approach: The Example of the Army's Basic Research Projects

To show how the approach works, we use the Army as the Service or DoD

agency, focusing on the Army's basic (6.1) research projects as an example application.[7] As such, we use the list of technologies found in the Army's fiscal year 1995 Research, Development, Test, and Evaluation (RDT&E) Program (known as the R–1) under the basic research heading (OCDoD, 1994). We limited our considerations to those technologies that showed a positive funding level for fiscal year 1995 (proposed). The list of Army basic research technologies is shown in the box on page 347.[8]

How the Basic (6.1) Research Technologies Were Placed Using the Approach

Using the technologies shown in the box, we placed them on the matrix assessment framework with the help of a group of researchers with backgrounds in engineering, operations research, business management, and the physical sciences. Experience levels ranged from five years to decades of experience in R&D issues. Every researcher had worked on Army R&D projects for at least several years, and all were familiar with the Army's current R&D program. In addition, most researchers had experience with commercial firms that did business with the Army.

"For computational convenience, researchers assumed a scale of zero to three for the market breadth axis and for the Army utility axis."

Each researcher was furnished with descriptive material on the technologies. To minimize the influence of current budget allocations on the placement of technologies on the framework, no budget information was included in the descriptive material, nor was it discussed or analyzed until the conclusion of iterative discussions to resolve differences in opinion on where some technologies should be placed.

Each researcher also received guidance on how to interpret the endpoints of the market breadth and Army utility dimensions of the framework.[9] For the market breadth axis, placement on the left-most portion of the framework indicated "close to Army unique" and placement in the right-most portion indicated "close to government and commercial uses" (generic). For Army utility, placement on the lower portion of the framework indicated that the technology's potential contribution to accomplishment of the Army's mission is low or small. For example, technologies that do not directly contribute to maintaining future combat capabilities should be placed near the bottom. Placement at the top of the framework indicates that the potential contribution the technology is expected to make is great (e.g., technologies that are critical to future combat effectiveness).

For computational convenience, researchers assumed a scale of zero to three for the market breadth axis and for the Army utility axis. A market breadth value of zero indicated potential Army uses only (Army unique), and a market breadth value of three represented potential government and commercial uses (generic). Similarly, an Army utility value of zero indicated low Army utility, and a value of three indicated high Army utility.

For each basic research technology shown in the adjacent box, each researcher

Army Basic (6.1) Research Technologies in the R-1
Artificial intelligence technology
Aviation technology
Ballistics technology
Chemical, smoke, and equipment defeating technology
Combat vehicle and automotive technology
Command, control, and communications technology
Computer and software technology
Electronic survivability and fuzing technology
Electronic warfare technology
Electronics and electronic devices
Environmental quality technology
Human factors engineering technology
Joint services small arms program
Laser weapons technology
Logistics technology
Manpower/personnel/training technology
Materials technology
Medical technology
Military engineering technology
Missile technology
Modeling and simulation
Night vision technology
Nonsystem training device technology
Weapons and munitions technology
Note: Army Basic Research includes four classified programs not shown in the table.

specified a market breadth value and an Army utility value. Each researcher worked independently to establish his initial values, with one researcher tabulating the results. The tabulated results showed consensus in most technology areas. For example, all researchers specified values for environmental quality technology that placed this technology in the monitor domain. Similarly, all researchers specified values for medical technology and computers that placed these technologies in the initiate domain. In addition, all researchers specified values for all classified programs that placed these technologies in the lead domain. However, there were also some technologies for which there was no initial consensus. For example, some researchers viewed night vision as a lead domain technology, while others felt that it was an initiate technology.

"To resolve these differences, the researchers held a series of discussions to try to reach a consensus."

To resolve these differences, the researchers held a series of discussions to try to reach a consensus. For this exercise, we considered "widely different values" to be values that differed by more than 0.5 and placed the technology in a different domain. The discussions methodically moved from one technology to the next, but the placement for some technologies required multiple discussions. The discussions took place once a week for about a month. For this exercise, we viewed values that would place the technology in the same management domain as a consensus. Hence, researchers could adjust their specification of values to reach consensus but still have some leeway to express their opinion about where the technology should be placed on the matrix.

The discussions resulted in modified values for some of the technologies by some researchers. Any remaining discrepancies were adjudicated by the group leader. After the discussions, we averaged the market breadth values and the Army utility values for each technology in each category. The pair of average values for each technology in each category determined the technology's placement on the framework.

RESULTS OF PLACING THE BASIC (6.1) RESEARCH TECHNOLOGIES USING THE APPROACH

Figure 2 shows the end result of the exercise of placing the Army's basic research technologies. We clearly see that the Army's basic research R&D is not a mass of homogeneous technologies. Of the 24 technologies considered (not counting the classified programs), only 6—one quarter—are categorized as having both a high Army utility and as Army unique in terms of market interest. Half of the technologies are both of high Army utility and of interest to nondefense industries, and another fifth of the technologies are both of moderate Army utility and moderate interest to industry. Only one technology is of low utility to the Army and high interest to industry.

This distribution of technologies shows that it may make sense for managers to take different approaches in managing the technologies. For example, those six technologies in the lead category are basically core Army R&D, technologies that are not of interest to industries other than some

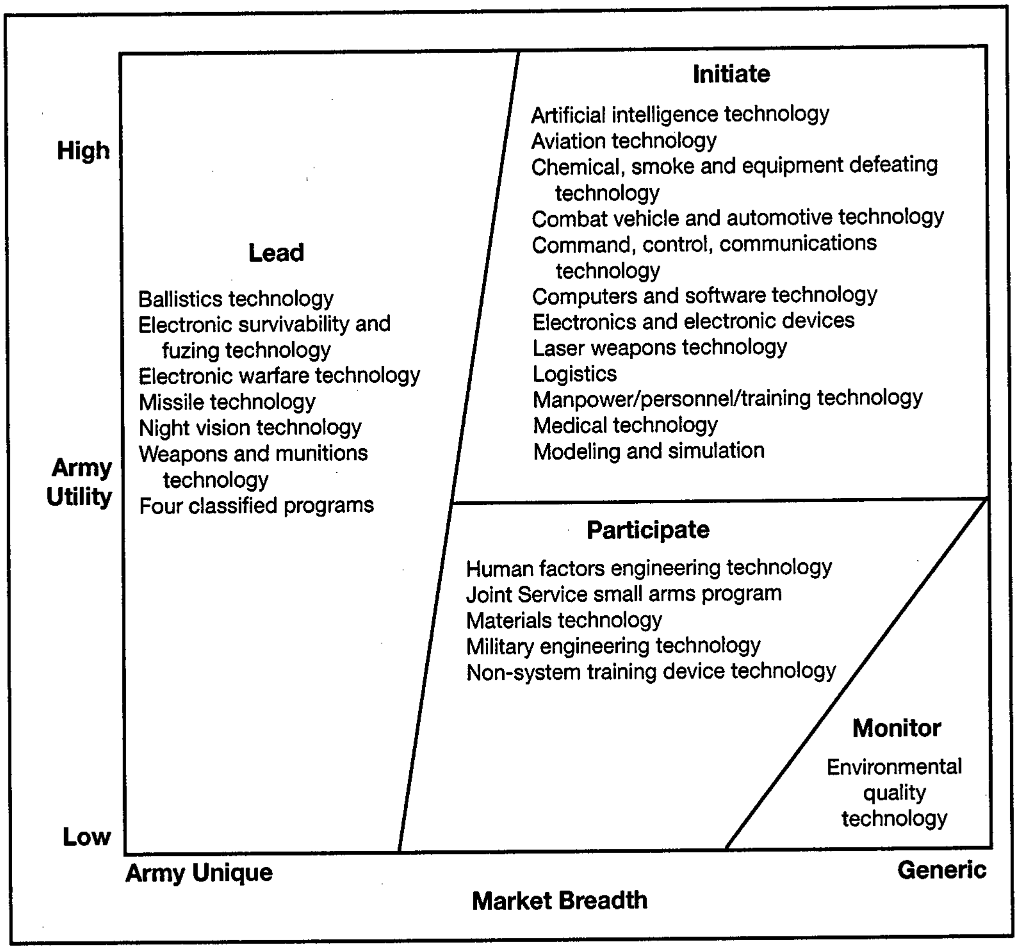


Figure 2. Placement of Basic (6.1) Research Technologies

military suppliers and ones that the Army likely has a strong technological lead in. These technologies will require complete Army funding and can be managed using basic contract mechanisms with traditional military suppliers.

However, the 17 technologies in the initiate and participate categories—which together represent nearly 75 percent of the total—are technologies in which the Army and nontraditional military suppliers in the commercial world have a mutual interest. Such technologies offer the potential for collaboration with industry, in some cases to save resources and in some cases to leverage off technological leads held by industry.

In fact, the Army has already started collaborative efforts to develop some technologies that fall into the initiate and participate domains. For example, in Project Plowshares, the Orange County, FL, local government is using Army-generated computer simulations to aid in disaster relief. And the Army Tank-Automotive and Armaments Command (TACOM) has

collaborated with the Big Three automobile manufacturers to form the National Automotive Center (NAC). Army and industry collaborative efforts are also ongoing in the information technology area.

Managing such collaborations will require something other than the standard contracts used for traditional military suppliers. To this end, cooperative agreements (CAs) and especially other transactions (OTs) are instruments more suitable for collaborative efforts. In 1989, Congress authorized CAs (in 10 U.S.C. §2358) and OTs (in 10 U.S.C. §2371) for use by the Defense Advanced Research Projects Agency (DARPA) as alternative mechanisms for conducting R&D. Authority to use CAs and OTs was extended to all of DoD, including the military Services, in 1991.[9] U.S. Code §2371 includes the category of "other transactions" as an essentially undefined term. DARPA has interpreted Section 2371 to mean that OTs are a class of transactions outside the procurement and assistance categories, and DARPA has implemented them as such since 1989, the time of the statute's original enactment.

"...there was consensus that environmental technology belonged in the monitoring category, since developing the technology is clearly not central to the Army's warfighting mission and the technology itself is well developed by commercial companies."

As mentioned above, there was consensus that environmental technology belonged in the monitoring category, since developing the technology is clearly not central to the Army's warfighting mission and the technology itself is well developed by commercial companies. While the Army will need to use the technology to deal with the environmental problems it faces on military bases, staying in touch with what is going on in industry and outsourcing as appropriate would seem to make more sense than developing the technology in-house.

Although not shown here, the distribution of the Army's exploratory development (6.2) technologies shifts toward the left side of the framework in the direction of the lead domain: lead, 30 percent; initiate and participate, 70 percent. This finding indicates that in addition to the collaborative opportunities in basic research technologies, the Army also has many potential opportunities to collaborate with industry in exploratory development technologies.

The distribution for advanced development (6.3) technologies shows a more marked shifted toward the left side of the framework: lead, 70 percent; initiate and participate, 26 percent; monitor, 4 percent. This finding is consistent with expectations. As a technology progresses from basic research, to exploratory development, to advanced development, and on to an identifiable product, the research becomes more specific in terms of its military application; hence, fewer collaborative research opportunities with industry would be expected. Therefore, the use of the matrix evaluation tool correctly indicated the expected decline of collaborative opportunities with industry as research progresses to a military product. However, the finding also indicates that more than 30 percent of the advanced development technologies are still good collaboration candidates, so ample opportunities for the Army to perform research

with industry still do exist for advanced development technologies.

Discussion

The application of the approach shows its value as a management tool. In a time of diminishing resources, being able to categorize R&D efforts into the four management domains can enable resources to be saved or reallocated. For example, while R&D efforts that fall into the lead category must be funded in entirety, those that fall into the initiate or participate domains can be cost-shared with industry; those funds can either be saved or used elsewhere to fund other R&D efforts. In addition, R&D efforts that fall into the monitor category require no real allocation of resources beyond what is necessary to keep abreast of the industry; thus, any excess resources could again be saved or diverted to R&D efforts elsewhere in the organization.

The ability to categorize R&D efforts into management domains also has some applicability as to how the efforts themselves are managed. While efforts in the lead domain lend themselves to standard contracts involving traditional military suppliers, those in the initiate and participate domains lend themselves to collaborative efforts using CAs and OTs. There may be some efficiencies and economies of scale to managing like efforts together—for example, all contract-based efforts versus all OT-based efforts.

In fact, the government has recognized that there are potential efficiencies to manage these collaborative efforts together and is anticipating a substantial increase in the use of collaborative instruments such as CAs and OTs. This recognition is made apparent by recent changes implemented by the Defense Contract Management Command (DCMC). DCMC has designated four regional offices to administer the Post Award Authority (PAA) of OTs and CAs and developed specialized expertise to do it. This new service is being provided to both the Services and to DoD agencies, such as DARPA. To facilitate the provision of this new service, DCMC will also provide limited assistance with pre-award negotiations where the use of CAs and OTs is being considered.

Our study shows that there are many technologies where the Army can benefit by performing collaborative R&D with industry. By using contractual instruments such as CAs and OTs and by taking advantage of the new services being offered by DCMC, the DoD has the tools to realize the benefits offered through DoD-industry R&D collaborations.

REFERENCES

Office of the Comptroller of the Department of Defense (OCDoD). (February 1994). *RDT&E programs (R–1) Department of Defense budget for fiscal year 1995.* Washington, DC: Author.

Saunders, K. et al. (September 1995). *Priority-setting and strategic sourcing in the naval research, development, and technology industrial base* (MR-588-NAVY/OSD). Santa Monica, CA: RAND.

Wong, C. (1998). *An analysis of collaborative research opportunities for the Army* (MR-675-A). Santa Monica, CA: RAND.

ENDNOTES

1. We examined a number of alternatives in our search for a tool. Ultimately, we adapted the concept of an alternative that was developed to categorize Navy technologies. See Saunders et al. (1995). For adaptation details on how the concept was adapted, see Wong (1998).

2. Defense transition from full funding and control of R&D to collaborative R&D with industry will require DoD organizations to examine each R&D technology area and decide whether it might be a candidate for collaborative efforts. The matrix described here is designed as a tool defense organizations can use to gain a first-order cut at which areas might be worth investigating as collaboration candidates. The matrix is not designed as a decision analysis tool to make definitive R&D project funding decisions. A decision on whether to collaborate and on the extent of defense funding contributed toward any collaborative effort would, of course, need to be made on a project-by-project basis after considering many factors, including the availability and suitability of industry partners, the precise areas of overlap, benefits to the government, security considerations, funding requirements, and schedule constraints.

3. We envision that individual DoD agencies and military services can use the matrix tool to determine which areas are collaboration candidates for a particular organization. Conceivably, a technology area that is a good collaboration candidate for one DoD group might not be for another DoD group because of different focuses, priorities, etc. In addition, using the tool effectively requires that the government be current and aware of the R&D that industry is performing in the technologies being considered for collaboration. This requirement can be met through the government experts who perform the "smart buyer" function, since adequate performance of this function requires both in-depth knowledge and currency.

4. We use the more general term "resources" to include cost and budget.

5. The domains shown in the figure have fuzzy borders. There is no line or curve on the framework above, below, left, or right of which a particular management approach can be judged most appropriate.

6. Government funding is likely to be needed for technologies in the lead domain because the market breadth of these technologies is limited to the government. This means that, for the most part, commercial applications of the technology have not yet been recognized. Hence, the government might not be able to find industry partners to collaborate with in pursuing these technologies.

7. Our focus here was on basic research (i.e., 6.1 activities); the other two S&T areas are exploratory development and advanced development, known as 6.2 and 6.3 activities, respectively.

8. The names of the technologies in the box are the names used in the R–1. Although the names of the technologies are generic, our placement of the technology on the matrix framework is based on the specific R&D activities that were funded by the Army during fiscal year 1995. That is, our placement of the technology does not imply that all research that might fall under the generic name would be in the domain shown in our Army illustration.

9. The matrix described earlier was modified to reflect the Army.

ACKNOWLEDGMENTS

The authors wish to thank their RAND colleagues, Howell Yee, Ike Chang, and Lucille Horgan for their technical assistance in critiquing the methodology and in helping apply it in the example shown. Special thanks go to Barbara Kenny for preparing the manuscript.

Bibliography

Congressional Research Service. (1993). *Is DoD the place to fund dual-use technology?* (93-496 SPR). Washington, DC: The Library of Congress.

Decker, G. (1994, December 2). *Authority to perform research and development using grants and cooperative agreements under 10* United States Code *§2358* (memorandum to the director, U.S. Army Research Laboratory). Washington, DC: Office of the Assistant Secretary of the Army for Research, Development, and Acquisition.

Defense Contract Management Command. *Agreements Administration Centers administration of other transactions.* Washington, DC: Defense Logistics Agency.

Department of Defense. (1995). *Dual use technology: A defense strategy for affordable, leading-edge technology.* Washington. DC: Office of the Under Secretary of Defense for Acquisition and Technology.

Department of Defense. (1995, February 27). *DoD grant and agreement regulatory system* (DoD 3210.6). Washington, DC: Author.

Horn, K., et al. (1997). *Performing collaborative research with nontraditional suppliers* (Report MR-830-A). Santa Monica, CA: RAND.

Jones, A. (1994, February 8). *Grants, cooperative agreements, and other transactions* (Memorandum to the Secretaries of the Military Departments [Attn: Service Acquisition Executives] and to the Director, Advanced Research Projects Agency). Washington, DC: Office of the Director of Research and Engineering.

Kuyath, R. (1995, Summer). The untapped potential of the Department of Defense's "other transaction" authority. *Public Contract Law Journal, 24*(4), 522–577.

Nash, M., et al. (1995). *Participant views of advanced research projects agency "other transactions"* (IDA Document D-1793). Alexandria, VA: Institute for Defense Analyses.

Proceedings of breakfast panel discussion—R&D prototypes using "other transactions": Kiss the FAR goodbye? (1995, April 13). Washington, DC: The Government Contracts Law Sections of the American Bar Association and the Federal Bar Association.

U. S. Air Force Materiel Command. *Model cooperative agreement under 10 United States Code §2371.* Washington, DC: Author.

U.S. Army Materiel Command. (1995). *Cooperative research and development agreements* (AMC Pamphlet 27-1). Alexandria, VA: Department of the Army Headquarters.

United States Code, Title 10, Chapter 139, Section 2358, Research Projects.

United States Code, Title 10, Chapter 139, Section 2371, Advanced Research Projects: Cooperative Agreements and Other Transactions.

U.S. General Accounting Office. (1996). *DoD research: Acquiring research by nontraditional means* (GAO/NSIAD-96-11). Washington, DC: Author.

A CASE FOR INTERNATIONAL COOPERATIVE ACQUISITIONS

LESSONS FROM DEVELOPING AND EXECUTING A SECTION 27 "QUAYLE" AUTHORITY PROGRAM

Dr. Alan Childress and Lt Col James Larson, USAF

This article sets out international cooperative program lessons that were learned from interviewing 29 past and present stakeholders from the United Kingdom Ministry of Defence, U.S. industry, U.S. government agencies, and joint program office personnel. Not surprisingly, the lessons learned suggest that devoting enormous energy and focus toward understanding each other's frames of reference and perspectives; striving to work together; establishing a well-defined, common requirement up front; and continuous senior-level support are factors critical to success in an international cooperative acquisition environment. We conclude with an evaluation of the program's organizational character.

In the spirit of maintaining past Secretary of Defense William Perry's strong advocacy for developing cooperative acquisition programs with our European allies, current Secretary of Defense William Cohen's March 1997 policy directive states, in part, that at the minimum the U.S. military must "leverage U.S. resources through cost sharing and economies of scale afforded by international cooperative research, development, production, and logistics support programs." In this article we present and discuss several lessons learned from an international cooperative acquisition—initiated in 1993—that largely achieves the objectives of Secretaries Perry and Cohen.

We note that D'Agostino (1996) evaluated and compared two multinational weapons development efforts, identifying multinational political and management issues that exacerbated technical and schedule problems. She described risk areas as including:

- number of countries and industries;
- differing and excessive requirements;
- complex cost share and technical work share decisions;
- consortia versus prime contractors; and
- international program office staffing and decision-making.

Our research, more focused in nature, complements, amplifies, and adds to her conclusions through identifying issues related to program establishment and management. While an acknowledged D'Agostino research limitation was the lack of a successful program—she based her findings on a canceled program and a new program—we studied an ongoing program that, notwithstanding schedule challenges, appears successful, despite the real and perceived barriers and risks encountered.

THE PROGRAM

The AN/AAQ–24 Directional Infrared Countermeasures (DIRCM) program is one of the U.S. Special Operations Command's (USSOCOM's) highest priority acquisition programs. This urgently needed aircraft self-protection suite will provide fast and accurate threat detection, processing, tracking, and countermeasures to defeat current and future generation infrared missile threats. DIRCM is designed for installation on a wide range of rotary and fixed-wing aircraft. For USSOCOM, the system will be installed on all of Air Force Special Operations Command's (AFSOCS's) AC–130 gunships and MC–130 *Combat Talon* aircraft. Growth to counter more sophisticated threats is incorporated into the program by providing a path that allows for direct insertion of a laser-based countermeasure when an all-band laser is developed. These capabilities made the DIRCM system, and others like it, strong candidates during USSOCOM's initial evaluation of the options available.

After careful consideration of the alternatives, USSOCOM initiated the DIRCM program as a cooperative acquisition with the United Kingdom Ministry of Defence (U.K. MoD) under Section 27 of the Arms Export Control Act (AECA) ("Quayle" Authority). Section 27 of the AECA authorizes the Department of Defense (DoD) to enter into cooperative projects with allies and friendly countries for cooperative research, development, test, and evaluation (RDT&E) or joint production (including follow-on support) of defense articles, concurrent production of a defense article that was jointly developed by the United States and allied or friendly countries, or U.S. procurement of a defense article or service from an allied or friendly country.

Lt Col James Larson, USAF, is a graduate of PMC 90-2, Defense Systems Management College. He is currently the Directional Infrared Countermeasures (DIRCM) Deputy Joint Program Manager (DJPM).

Alan Childress, Ph.D., is a management consultant with Booz-Allen & Hamilton.

"Quayle" Authority (Section 2350b) enables DoD to waive certain contracting and procurement requirements in carrying out contracts under a Section 27 cooperative project.

Prior to program inception, the two countries' procurement and legal staffs developed and negotiated an acceptable Memorandum of Understanding (MOU). Given the program's urgency and a strong desire on the part of the participants to establish a firm foundation for the program's success, both staffs felt the best means to keep the negotiations on track was to leave out politically charged items such as cost and work share arrangements. Within the framework of the "Quayle" Authority, the DIRCM MOU allows the U.K. MoD to competitively award a contract on behalf of USSOCOM. The U.K. MoD owns and manages the contract with the DIRCM prime contractor, Northrop Grumman Electronics and Systems Integration International, Inc., (NGESII) Rolling Meadows, IL.

The DIRCM program is unusual in that it is one of the first cooperative development and production projects undertaken by a U.S. agency wherein the allied country owns the contract with industry. In addition, it may be the first program where the U.K. MoD has led a collaborative procurement with the United States in which the prime contractor is one of the major U.S. defense contractors.

Total U.S. programmatic cost savings, documented in the program's 1996 David Packard Acquisition Excellence Award narrative, amount to $80 million.

Overview of DIRCM Program Management

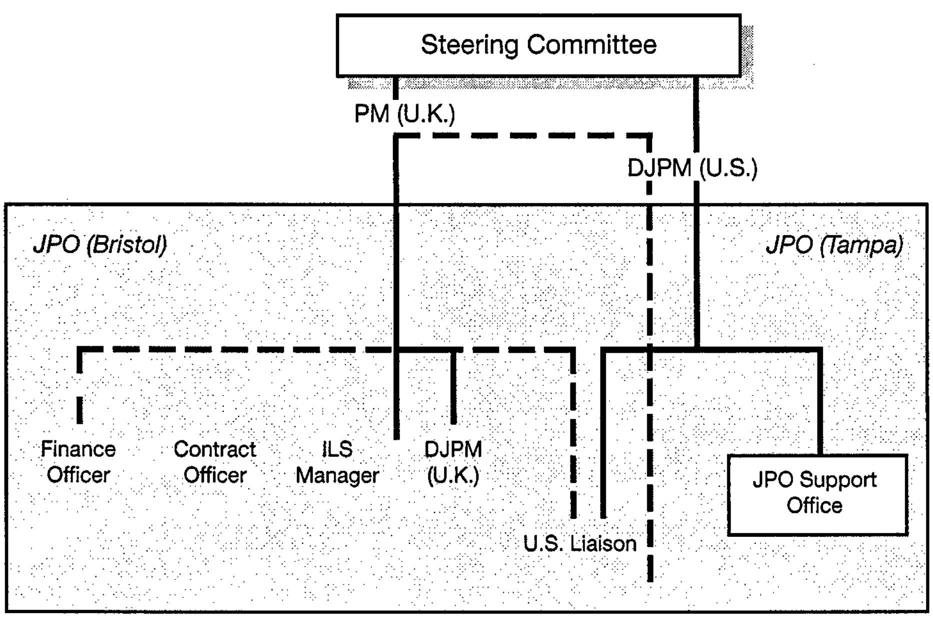
As noted, the U.K. MoD owns and manages the DIRCM contract, currently valued at over $400 million for joint U.K./USSOCOM content as well as United Kingdom- and USSOCOM-unique requirements. The contract is to develop, produce, install, field, and sustain approximately 131 DIRCM systems on the U.K. fixed- and rotary-wing fleet and 59 systems on the AFSOC AC/MC–130 fleet. The fixed-price (FP) basic contract, awarded under a total systems performance responsibility (TSPR) philosophy, is for the joint engineering, manufacturing, and development (EMD) phase and U.K. production and sustainment phases, and includes priced options for USSOCOM's production and sustainment phases. The MOU to enter into a cooperative program between the United States and the United Kingdom was signed in June 1994 and the EMD contract with Northrop Grumman was signed in March 1995.

> **"...both staffs felt the best means to keep the negotiations on track was to leave out politically charged items such as cost and work share arrangements."**

The DIRCM program manager is a U.K. Ministry of Defence (MoD) civilian. There are U.S. and U.K. joint program offices (JPOs), with each office headed by a deputy joint program manager (DJPM). The USSOCOM JPO at MacDill Air Force Base, FL, is staffed by a handful of military and civilian managers, augmented

by a team of contractor technical support personnel. The MoD JPO in Bristol, England, is staffed by several full-time U.K. civil servant managers and one USSOCOM civil servant, augmented by off-site specialized engineering support. The U.K. program manager is co-located with his U.K. deputy in Bristol. In addition, the United Kingdom has placed an Integrated Logistics Support (ILS) manager on-site at the prime contractor. A steering committee comprises U.K. and U.S. acquisition executives (Figure 1).

In addition to providing functional (engineering, test, ILS, software, etc.) consultation to the U.K. program manager, USSOCOM is responsible for managing program-wide developmental testing at U.S. test facilities such as the Air Force Electronic Warfare Evaluation Simulator (AFEWES), Army Research Laboratory (ARL), Eglin Air Force Base test ranges, and the White Sands Missile Range Aerial Cable Facility. USSOCOM also assists in the execution of that portion of the contract to outfit the Air Force Special Operations Command (AFSOC) AC/MC–130 fleet with DIRCM systems. The USSOCOM JPO is managed through a two-tier integrated product team (IPT) structure, with U.K. and prime contractor representation in the upper tier. These IPTs draw extensively on Service and OSD expertise in the areas of engineering, test, logistics, and aircraft integration. Presently the program is in the latter stages of



(Note that the dotted line depicts the division [invisible in practice] between the JPO [Bristol] and the JPO [Tampa].)

Figure 1. The Steering Committee for the Joint Program

EMD, with production scheduled to start in 1998.

Data Sources and Research Purpose

The sources of research data for this study were program documentation and individual interviews with 29 key decision makers, stakeholders, managers, and functional experts substantially affecting the DIRCM program, past and present. In addition to a semi-structured interview format designed to gather programmatic and technical data, interviewees were asked what lessons they learned (and related observations) from their involvement in the DIRCM program. We generally conducted the interviews in the home office of interviewees or in a neutral setting. The research purpose was to document DIRCM's experience in the form of lessons learned. In particular, we wished to share the program's Section 27 "Quayle" Authority successes and shortcomings with future international cooperative programs.

Lessons Learned

Summarized Section 27 and related lessons learned, and the associated rationale for these experiences, are categorized as follows:

- drafting and negotiating the MOU;
- defining the requirement;
- cross-cultural communications and teamwork;
- personalities, professional skill sets, and motivation;
- writing, negotiating, and executing the contract;
- TSPR/FP-type contracting;
- management continuity;
- contractor program management support;
- IPT management; and
- leadership.

Drafting and Negotiating the MOU

Lesson: When contemplating a Section 27 program, seek Service headquarters or OSD assistance and sponsorship.

Rationale: The first USSOCOM DIRCM program manager learned from OSD officials at a very early stage that if he worked the MOU procedures himself through USSOCOM channels, the MOU process could take 18–24 months rather than the 6–8 months he could afford for AFSOC's urgent requirement. No Section 27 "Quayle" Authority (the allied country is the procurement agent) codevelopment, coproduction procurement had been seriously contemplated before; USSOCOM would have had to develop the documentation internally and staff it through the Joint Staff and the cognizant Services. He asked a key OSD mid-level acquisition official for help and received it. The OSD official and the U.K. program manager said that direct senior executive involvement would be very helpful in expediting the MOU process. The USSOCOM acquisition executive (AE),

an innovator in tailored acquisition, made supporting calls for cooperation to OSD and U.K. MoD acquisition executives. This direct high-level support from the beginning also sent a powerful message to the United Kingdom that USSOCOM was seriously interested in a cooperative effort.

Lesson: Enlist experienced negotiators to help negotiate the MOU.

Rationale: Allied countries have professional negotiators who consistently outperform less experienced U.S. negotiating teams. The Defense Security Assistance Agency (DSAA) General Counsel, who helped negotiate the DIRCM MOU, suggests that the U.S. defense establishment should not "send a boy out to do a man's work. [We] need to send out on a negotiating team experienced people who 'know how to/been there/done that.'" The skilled OSD-led negotiating team was very successful in achieving USSOCOM's objectives. Equally significant, the team completed the negotiations in the very short period of a week and with very little acrimony (which could have seriously jeopardized long-term relationships on the program). (Note: The authors recognize DSMC's international management training courses. One, Alan Childress, is a graduate of the Advanced International Management Workshop and highly recommends that training to anyone contemplating international cooperative acquisitions.)

> **"Allied countries have professional negotiators who consistently outperform less experienced U.S. negotiating teams."**

Defining the Requirement

Lesson: A well-defined, focused requirement that includes a commonality of interest is essential for success. Both sides must strongly desire to do the same thing.

Rationale: In the early stages of forming the partnership, the U.S. and U.K. program managers encountered several obstacles, some caused by cultural differences and baggage from earlier unrelated attempts at cooperative efforts that had failed. These obstacles could have easily threatened collaboration. The significant savings in time and money was very important to collaborating; however, the goal of defeating a similar list of threats under like scenarios of operation was the common thread that secured, and continues to secure, the partnership. The interviewees advise future program managers to acknowledge and value differences while working hard toward mutually beneficial solutions and avoiding compromises that dilute the objectives of one of more of the parties.

Lesson: Section 27 works best if, in addition to a common requirement, the partnership is formed from the bottom up.

Rationale: Early in the program, the U.S. DIRCM managers discovered there were common U.S. and U.K. requirements they could merge for joint execution. Both countries were in formal stages of going forward with similar needs. When U.S. program-level officers approached the U.K. program manager and his deputy with congruent requirements, as well as resources, they saw that a good marriage was possible. As a result, combining the efforts was approved all the way up the chain. In contrasting cases, according to former DSAA General Counsel Susan

Ludlow-MacMurray, both countries already had their own programs ongoing when they were directed from the top, politically, to merge, which caused dilution of authority and responsibility and dissatisfaction in one or both sides' management. She suggests that international programs driven by bottom-up motivation generally succeed. Those programs that emanate from the top down (Service Secretary or OSD level) generally do not succeed; they die from lack of a mid-level buy-in or sponsorship.

Cross-Cultural Communications and Teamwork

Lesson: Approach a potential international cooperative acquisition partner with a very small team of highly skilled people and plan to agree to limit the number of U.S. program staff participants directly involved in program startup and execution.

Rationale: The British were apprehensive that a large, Service-level program would attempt to subsume their ongoing program once a cooperative agreement was in place. They made this point clearly and pointed out past examples of failed efforts when approached by the U.S. team. Their primary concern was that of losing control and the focus of meetings if attended by a large U.S. contingent. They clearly stated they would pull out of an agreement if the United States attempted to modify their schedule or could not accept junior partner status. After a few meetings, they saw that the USSOCOM organization was relatively small and agile and, like them, embraced acquisition streamlining.

Lesson: Each side in an international cooperative program must dedicate an enormous effort to understand the culture, motivations, and idiosyncrasies of the people and bureaucracies of the other country.

Rationale: U.K. interviewees emphasized that realizing the magnitude of cultural differences was quite a shock. The first U.K. DJPM said working together on this program illustrates the true meaning of the concept of "two countries divided by a common language." He recommends taking a gloves-off approach and telling each other clearly and openly how issues are being viewed, or be prepared to suffer the consequence of miscommunication. Two U.K. interviewees stated that commitment from senior management on both sides is an absolute requirement to allow enough interchange between the people doing the job. They are not sure there had been sufficient senior management emphasis on the DIRCM project to achieve the level of cooperation that might have been. In particular, they feel senior managers might have committed more travel resources to allow this interchange.

"Each side in an international cooperative program must dedicate an enormous effort to understand the culture, motivations, and idiosyncrasies of the people and bureaucracies of the other country."

U.S. interviewees suggest that a U.S. DJPM must, at times, look at things through the eyes of his or her counterpart to understand the other's point of view. For example, a U.S. DJPM had a difficult time agreeing with his counterpart on an

accurate assessment of the program's schedule. In his eyes the program had slipped a considerable amount, on the order of 12 months. The U.K. DJPM maintained just as strongly that the program had hardly slipped at all, maybe one or two months. After having this disagreement in front of the respective acquisition executives, the U.S. DJPM came to realize the British typically measured programs in relation to the end date of the contract, while the United States typically uses initial operational capability, or when the system first makes it to the field. In the U.S. case, the initial operational capability had slipped 12 months, but the contractor was able to adjust production and installation scenarios to maintain the same contract end date. Essentially, both DJPMs were right, locked in violent agreement. They just did not know it.

"Two British interviewees commented on the synergism realized from international cooperation."

Lesson: When assigning functional expertise, U.S. program managers should strive to achieve a synergistic balance with other participants' team members. By drawing on key areas of expertise from each country while trying to avoid too much overlap (and high potential for personal competition and conflict), the overall team will be more effective and agile.

Rationale: Two British interviewees commented on the synergism realized from international cooperation. One suggested that while either side would have done a grand job on its own, "the fact that (the technicians) know how to bounce things off each other has been a great benefit; we should keep that well in our sights...and on the management side there are differences in approach, which, pooled together, benefit both parties." DIRCM's MoD executive, John Allen, noted that "no doubt USSOCOM has a better knowledge of both U.S. industry generally and Northrop in particular. Both sets of experience brought to manage one particular contract is working well...Northrop Grumman knows that USSOCOM is a better-informed customer than we are...we can draw from that experience." A Northrop senior manager commented that the integration of U.K., USSOCOM, and Northrop technical specialists "has been outstanding...benefits to the United Kingdom and United States in operating that way are tremendous. I can't over-stress that." DIRCM's program manager argues that from the collaboration he is "absolutely committed that we are both getting a better product out of this."

Personalities, Professional Skill Sets, and Motivation

Lesson: When contemplating the formation of an acquisition partnership with a potential international partner, U.S. agencies should recruit or place their most technically competent, strongest personalities in the initial contact and management teams.

Rationale: U.K. program officers remarked that they were very impressed, particularly in the early stages of forming the DIRCM partnership, by the personalities, drive, and desire to succeed of the founding U.S. program team members. They suggest the marriage probably would not have happened without the intense interest of an OSD supporting official, or the doggedness of the first DJPM to "make

it happen." The British look hard at personalities when contemplating a business relationship. The USSOCOM AE, Gary Smith, was seen as an acquisition innovator with whom they could do business.

Lesson: U.S. decision makers should implement a deliberate personnel policy to hire or place and retain the best program management and technical skill sets available for Section 27 programs. In addition, executives should attempt to recruit personnel with international cooperative acquisition training and experience (see Lesson 1, Drafting the MOU).

Rationale: The U.S. AE's placement of management personalities and overlapping skill sets is a positive lesson. The first DJPM was a contracting officer, acquisition professional, and operator. The second DJPM's background was operations and acquisition. The current DJPM is an acquisition professional, while the support contractor technical director has an operational and acquisition professional background with experience as a program manager in industry. First-rate technical professionals were hired to support these managers. The U.K. program manager professed he is understanding of the fact that U.S. personnel must learn his way of doing business as well as sustaining U.S. policies and procedures.

Lesson: When entering into an acquisition partnership where the other country owns the contract with industry, the U.S. side must be prepared to accept a subordinate management role.

Rationale: U.K. and Northrop Grumman officials point out the positive effect on the relationship resulting from USSOCOM team recognition, from the outset, that DIRCM would be a U.K. contract. The first U.K. program manager made it clear early in the project that he was the program manager, that he called the shots, and that the contract terms were United Kingdom terms, not those of the United States. When the first and second U.S. DJPMs were in London during the contract negotiation process, they worked with the U.K. program manager and did not try to lead him. A good illustration of this lesson is told by Northrop's contracting director. He was attending a briefing by the U.K. program manager, sitting behind the overlapping U.S. DJPMs during their changeover phase. He said the second U.S. DJPM (then-Lt Col Karl "Chip" Kochel) turned to his predecessor (Lt Col Jim Pennock) and asked a question. Pennock's reply, as he pointed to the U.K. program manager, was "Ask your program manager."

"The first U.K. program manager made it clear early in the project that he was the program manager, that he called the shots, and that the contract terms were United Kingdom terms, not those of the United States."

Writing, Negotiating, and Executing the Contract

Lesson: When negotiating an allied-led RDT&E TSPR/FP contract with U.S.-based defense firms, the program manager, with the U.S. Deputy DJPM, should meticulously precoordinate the developmental and operational testing terms, conditions, and standards with the appropriate U.S. test agencies.

Rationale: The U.K.-owned EMD contract with Northrop Grumman gave Northrop total systems performance responsibility, including developmental testing. The testing program included the use of U.S. Air Force test activities. Differences in test standards, procedures, and philosophy emerged after development was under way and have continued to plague the program manager. U.K. interviewees, while admitting that DIRCM technology presents unanticipated test challenges, argue that there has been a tendency from the U.S. test community to try to run testing as if it were a cost-plus type development contract, when in fact it is a fixed-price contract. Two Northrop Grumman officials suggest that the program manager, with program goals in mind, should have the final word regarding testing. It has not worked out in that manner, causing confusion at times.

"In cooperative acquisitions, certain elements of the requirement may be unique to each country."

Lesson: When developing the Section 27 contract with industry, write a U.S.-only portion of the contract to help in obtaining support-system information; tie U.S. payments to contract data requirements list (CDRL) deliveries.

Rationale: In cooperative acquisitions, certain elements of the requirement may be unique to each country. For example, U.S. logisticians require product and contract information to establish a cost-effective support infrastructure. Also, the "system" requires them to have a contract number in the U.S.-contract-number format since their software does not accommodate the contract number format used by some other nations. In addition, contract specifications are generally more unbounded, causing U.S. JPO logisticians a small problem managing compliance, particularly with regard to the CDRLs (contract deliverables). The delivery of data, in some cases, is more important than the product itself.

TSPR/FP-TYPE CONTRACTING

Lesson: When faced with total systems performance responsibility/fixed price (TSPR/FP)-type contracting in a cooperative acquisition, U.S. DJPMs and U.S. contractors should take care to fully understand the concept of TSPR/FP contracting and the pitfalls of execution in the U.S. acquisition environment.

Rationale: TSPR/FP contracting is generally not alien to the U.S. acquisition culture; however, for various reasons U.S. agencies tend to drift away from implementing true TSPR, especially during times of technical challenges. At times the temptation for U.S. program managers and their functional team members is too great to resist getting directly involved in "helping" the contractor work through the problems. However, this approach typically ends up with the government performing work or functions that the prime contractor was paid to do while at the same time possibly absolving the contractor of responsibly for failing to perform.

While the United Kingdom fully supports and accepts Northrop Grumman responsibility and judgment on the requirements, the U.S. JPO and Northrop are experiencing problems with U.S. inspection and test agencies acceptance of TSPR. For example, a Northrop Grumman interviewee complains that the Defense

Contracts Auditing Agency is inspecting their Group A component installation on an incremental basis as they deem fit, but Northrop does not have "incremental absolution" to go along with the inspection. Northrop still has, at the end of the program or at the end of the modification, the obligation to present it to the government and the government has the right to accept or reject, even though they agreed on something in the normal course of doing the modification.

An interesting compromise between U.K. and U.S. contract management approaches has emerged in the DIRCM program. The U.S. side introduced a review process to TSPR contracting. The contract is being executed using this review process to help the contractor, but the government does not sign off on formal review documents. In the words of a DJPM, "Northrop performs on the contract and we oversee their performance. If they convince us that it's great and they are ready for preliminary design review (PDR), we complete that event; if they convince us they are ready for critical design review (CDR), then that is fine. Or if they are not ready in any review, they don't go into the next event until it's satisfactory." While the review process is not contractual, it appears to strike a balance between the U.S. cost-plus "stay in their knickers" approach and the "hands-off" British TSPR system. In the DJPM's view, it puts the government in a better position to help the contractor work through problems in early stages, "If you wait, you are going to create a wave that you can't overcome." Finally, according to the present U.S. DJPM, TSPR/FP contracting, combined with IPT management, is saving enormous program office resource costs.

Management Continuity

Lesson: The complexity of managing Section 27 codevelopment programs, along with the benefits of preserving established international personal relationships, requires that decision makers establish and maintain a management structure that provides management continuity and overlaps systemic personnel rotation.

Rationale: When the first U.S. DJPM was notified of his reassignment, the U.K. team was worried about the impact of losing such a strong player on short notice. They stated their concerns, and were relieved knowing that the contractor technical director would be the "glue" person to hold the U.S. side together during the transition. They claim his technical expertise and personality were critical in the U.S. DJPM transitions. The founding U.K. program manager stated that, "The contractor management support key players have been providing the continuity that the majors and lieutenant colonels haven't been able to provide. That was important. It couldn't have happened without that continuity." According to him, the British have an ambition that their program managers should stay about three or four years minimum.

"Finally, according to the present U.S. DJPM, TSPR/FP contracting, combined with IPT management, is saving enormous program office resource costs."

This concern relates to contractor as well as military management. Regarding Northrop's management turnover, the senior U.K. interviewee stated that the present management is very good, but "nevertheless the continuing change of

personalities within the company is not very reassuring and we continually have to watch that."

CONTRACTOR PROGRAM MANAGEMENT SUPPORT

Lesson: When structuring and maintaining an international program office, contractor management support provides the program manager choices in tailoring, flexibility, and continuity not available in an all-government solution.

Rationale: Contractor-provided management support was vital to forming and maintaining the U.S. JPO; the government billets and technical expertise were not available during program formation. The USSOCOM AE commented that "we used to have a very large laboratory structure that provided us in-house expertise, but that's going away. We have to hire contractors that have the in-depth expertise. It's sensible to hire technical support in today's downsizing environment." The first DJPM relied on Systems Engineering and Technical Assistance (SETA) support because, "You need a core of civilians that can maintain continuity across the program." The present DJPM maintains that through contractor-provided management support: Taxpayers get a break in that programs do not have to carry inappropriate personnel; the contractor selection process tends to attract and maintain the best people; and the JPO tends to exhibit greater teamwork among functional areas through contractor personnel.

"The USSOCOM AE commented that "we used to have a very large laboratory structure that provided us in-house expertise, but that's going away."

IPT MANAGEMENT

Lesson: A controlled IPT process is essential to effectively managing a complex and geographically scattered Section 27 program.

Rationale: Before implementing IPT management, the U.S. DJPM was having significant problems integrating and controlling his extended acquisition organization. The program office was small, with support staff and stakeholder organizations scattered globally. Support organization staff were communicating and deciding among themselves, without including the JPO in the loop. The IPT process sharply reduced those control problems and brought a spirit of teamwork and accomplishment to the DIRCM program. Also, according to a U.K. interviewee, "Cutting down meeting participation (through the USSOCOM's use of IPTs outside of normal joint U.S./U.K. meetings) helps because one of the problems that we had, certainly early on, was at each meeting there would be somebody new who really knew very little about the program and what had gone on in the past. And they'd start asking the questions that were addressed 2 or 3 months ago. It was always as if we had to bring them up to speed before the meeting could proceed."

A DJPM interviewee made these recommendations for creating IPTs:

- Ensure top-level support through review and signature on the IPT charter.

- Get the right disciplines and individuals on the team; include industry. As the IPT leader, the DJPM manages membership and participation.

- Manage the meetings and keep them focused. Do not allow old issues to be reopened if they have already been closed by mutual agreement.

- Keep the meetings on track to preclude the waste of time.

- Only address the highlights of each functional area/topic.

- Encourage the functional representatives to create their own mini sub-IPTs, working the details in them rather than bringing detailed technical issues to the overall IPT forum.

Leadership

Lesson: Involved and decisive leadership, from the top down, is particularly essential to a Section 27 program.

Rationale: In the early days of forming the partnership with the United Kingdom, indecisiveness on the part of the U.S. leadership would most likely have resulted in failure. An industry interviewee observed this of the program, "A key element in making the program work was a leader that was involved, that was willing to make a decision and move forward. We had good examples with the first DJMP and the AE, up front making a decision and going ahead and doing something rather than sitting around trying to figure out the best way to do things. They fought it out, made a decision, and moved on. That was critical, to have a decision maker who made a decision and pushed hard."

Conclusions

Growth of Related Cooperative Ventures

The evidence indicates, in general, that the two-country team has fostered strong relationships based on technical expertise and trust, plus both countries had something to offer the other. The payoff to both has been additional cooperative efforts.

To date the U.S. JPO has negotiated and signed an MOU amendment to further cooperate with the U.K. MoD on an advanced Missile Warning System (MWS) technology assessment program. Work under this MOU amendment may yield technology that could be used in the planned upgrade program for the baseline DIRCM missile warning sensor.

Further, the U.S. JPO is in the final stages of negotiating another MOU amendment to cooperate on a laser technology assessment program. As with the advanced MWS, technology developed here could be transitioned into the planned upgrade to add a laser-based countermeasure.

"The evidence indicates, in general, that the two-country team has fostered strong relationships based on technical expertise and trust, plus both countries had something to offer the other."

Lessons Learned

The DIRCM program was researched so that future international cooperative acquisitions may directly benefit from it's experiences. Each of the 29 people interviewed for the study offered lessons pertinent to their areas of interest, the more important of which are summarized above.

The lessons that the majority of interviewees agree on collectively are synopsized below to aid the reader looking for this article's "bottom line" of successful international collaboration. Programmatic conclusions follow.

- Each side must strongly desire to achieve the same well-defined, focused requirement while being able to offer some technical benefit to the other side. In general, if one or more of the MOU participants appear to have little or no technological benefit to offer the remaining participant(s), the mismatch, real or perceived, will not allow the cooperative effort to get off the ground.

- Each side must dedicate an enormous effort to understand the culture, motivations, and idiosyncrasies of the people and bureaucracies of the other country.

- Strong personalities and technical competence are essential in the initial contact and management teams.

- International cooperative programs can achieve increased synergistic results if the managers take care to staff their technical teams to complement, rather than mirror, each other.

- When a junior partner, the U.S. side must be prepared to accept a subordinate management role. We note an overall theme that emerged from D'Agostino's (1996) research "for success in multinational programs that have been well-selected, national political issues and pride need to be subordinated to what is best for the program."

- Precoordinate contract technical and testing terms, conditions, and standards among all involved agencies.

- U.S. DJPMs should plan, as much as possible, on conducting their side of the program consistent with the DoD 5000 Series, even though a Section 27 "Quayle" Authority program may be conducted in accordance with the other country's laws and acquisition procedures. This approach will pay off in the short and long term by providing the required information in a familiar format to the appropriate staff agencies.

- The U.S. acquisition system has experienced a revolution through recent acquisition reform initiatives. However, U.S. personnel should avoid the tendency to see their acquisition system as superior to all others. It is working under a unique set of circumstances, statutes, industry capabilities, and congressional oversight.

- Make effective use of priced production and sustainment options during the competition. The United Kingdom awarded development and production together, giving up significant leverage in the process.

- Look closely at manning decisions when creating program offices. Each country's program office should have a representative from the other country. Consideration should be given to prime contractors and major test facility locations when making final manning decisions.

Programmatic Conclusions

While the DIRCM program has enjoyed noteworthy success in its Section 27 "Quayle" Authority environment to date, the interviews hint that not all has been smooth and trouble-free—the program experiences its share of technical problems. The evidence suggests that DIRCM was acknowledged and formulated as a high-performance and schedule-risk program. Urgent warfighter need for infrared missile protection by USSOCOM and U.K. MoD aviation units dictated a truncated, perhaps ambitious acquisition schedule. That schedule appears to amplify technical problems which may otherwise be classified as typical of an acquisition program at this stage.

Untypical, however, is the teamwork approach of the program's people in anticipating emerging problems and wrestling them through to resolution. Teamwork and a program-office-wide work ethic—the desire to succeed and achieve—led us to examine perhaps the central reason for the program's success: organizational character. We thought future international cooperative program managers might be interested in this notion when establishing their program offices.

In our view, the program's originators established a core ideology (values and purpose) that has been foundational to DIRCM's success in its unique, relatively complex, Section 27 environment. According to Collins and Porras (1996), core ideology—defined as the enduring character of an organization—is the most lasting and significant contribution of those who build visionary organizations. Core ideology provides the glue, the consistent identity, that holds an organization together through time. Core ideology is not intentionally created or set; one discovers core ideology. In their model, core ideology has two distinct parts: core values, a system of guiding principles and tenets; and core purpose, the organization's most fundamental reason for existence.

In the case of DIRCM, core *value* is the program organization's spirit or culture of teamwork. The teamwork culture was started by the OSD, U.K. MoD, AFSOC, and USSOCOM founders—who were determined to work and succeed together as a team—and continues in the program today. With few exceptions, members of the DIRCM team have put teamwork above any company, Service, promotion, or other parochial interest. The evidence suggests that without the teamwork spirit at its core, the organization would not have successfully expanded, through IPT management, to involve the many geographically and functionally scattered stakeholders.

"Core ideology provides the glue, the consistent identity, that holds an organization together through time."

Core *purpose,* DIRCM's most fundamental reason for existence, is urgent warfighter protection. Purpose, not to be confused with programmatic goals or strategies, is the vision of a light beam defeating an enemy missile seconds out from destroying an aircraft and its crew. With its roots mainly in the memory of a Special Operations aircraft downed in the Gulf War, purpose has held the organization's key members together through several disruptive and divisive business and government reorganizations. There are no indicators it will abate prior to fielding and sustainment.

REFERENCES

Collins, J., & Porras, J. (1996, September-October). Building your company's vision. *Harvard Business Review.*

D'Agostino, D. (1996). Transatlantic cooperative weapons development: How can we better ensure success? *Acquisition Review Quarterly, 8,* 131–146.

THE COSTS AND BENEFITS OF THE EARNED VALUE MANAGEMENT PROCESS

David S. Christensen, Ph.D.

Up to now assessments of the earned value management process have focused on either the positives or the negatives—but a complete and objective evaluation has not been made. This review surveys the literature and paints a balanced picture of the issue.

Do the benefits of the earned value management process exceed its costs? Several published studies report the costs but ignore the benefits. Others focus on the benefits, but ignore the costs.

A widely circulated report by Coopers & Lybrand and TASC (1994), for example, concludes that the Department of Defense regulatory cost is significant, and the requirement for earned value management systems (EVMS) criteria is among the largest cost drivers. But in this study the benefits of the earned value information derived from criteria-compliant contractors were not considered. Clearly, a report that addresses only the costs or the benefits of earned value can be misleading. Both the costs and the benefits of earned value must be assessed.

Here I provide a comprehensive literature review, and summarize and synthesize studies reporting the costs or the benefits of earned value. The result is a more complete and objective evaluation of the earned value management process.

Earned Value and EVMS

There is a difference between earned value and EVMS criteria. Earned value is a special metric that can be used to manage any project. The criteria are standards for management control systems that use earned value. Since 1967 the criteria have been required on large, flexibly priced defense contracts. The purpose of the criteria was to assure the reliability of the earned value metric. Although earned

value does not require the criteria, it does require a management control system that meets at least some of the standards described by the criteria. In this paper, the term "earned value management process" includes both earned value and the EVMS criteria.

Earned Value

The earned value concept originated in industry and was developed primarily by the Department of Defense (DoD) as a management tool for use on defense acquisition contracts. Earned value is a metric devised to achieve meaningful comparisons between planned and completed work. It is similar to what accountants call a "flexible budget," where the original budget for work is adjusted for the actual level of output. Cost variances result when the actual cost of the work and its flexible budget (earned value) differ. Significant variances are analyzed to identify and correct problems before they worsen.

A major difference between a flexible budget and earned value is the time dimension associated with earned value. Initially, the work on a project is divided into pieces, assigned a budget, and assigned a schedule. Because each increment of work is time-phased, a schedule variance occurs if work is not completed (earned) when it was scheduled to be completed. Because the work has a budget, the schedule variance is often reported as a dollar amount. The flexible budget used in cost accounting does not provide any information about schedule variances. Like the cost variances, significant schedule variances are analyzed and corrected when possible.

When variance analysis is conducted properly (e.g., on time, and at the proper level), it can be an effective control against further cost and schedule problems that may jeopardize the successful completion of a project. Unfortunately, variance analysis can be untimely or excessive and even contribute to project failure by drawing project managers, engineers, and others away from more urgent problems.

EVMS Criteria

A key to the effective use of earned value is an adequate management control system that fosters the proper planning and integration of work on a project. EVMS criteria define the attributes that management control systems must possess for earned value to be used effectively. Originally, the criteria were established by the Air Force as cost/schedule planning and

David S. Christensen is an associate professor of accounting at the University of West Florida. After receiving a Ph.D. degree from the University of Nebraska in 1987, he joined the faculty at the Air Force Institute of Technology (AFIT), where he stayed for 10 years. While there, he taught courses on earned value, including earned value management control systems criteria. He also led a long-term research project on cost management topics related to earned value. Christensen holds several certifications and is active in several professional associations, including the Society of Cost Estimating and Analysis. He has published extensively in the area of earned value.

control specifications (C/SPEC) for application on major defense acquisition contracts. Later the criteria were adopted by all the military services as cost/schedule control systems criteria (C/SCSC). Recently, the criteria have been slightly revised and renamed earned value management control systems criteria (DoD, 1996).

Despite the multiple names, the criteria have not changed significantly since their inception. Presently, there are 32 EVMS criteria, organized into five categories, that pertain to major project management activities:

- organization;
- planning and budgeting;
- accounting;
- analysis; and
- revisions.

Each criterion addresses a major principle necessary for effective management of large, flexibly priced defense projects. For example, one criterion requires that each element of work on the project has a budget. Another criterion requires that each element of work has a schedule. Without a budget and a schedule, it would be difficult to properly manage a project of any size, much less a major defense project that can cost over a billion dollars and last for many years. Thus, criteria are often described as common-sense management practices that any well-managed defense contractor would use.

Over the years, however, implementing the criteria became an administrative burden that was eventually viewed as a non-value-added activity by contractors and program managers (Government Accounting Office, 1997). Like many government documents, the DoD's Joint Implementation Guide (JIG), which described how to implement the criteria, grew in size and complexity (DoD, 1987). Its checklist of 158 questions (Appendix E of the JIG) was often perceived as a contractual requirement and administered with audit-like rigor by the review teams. Additionally, earned value data was mistakenly judged "guilty by association" and occasionally ignored by project managers who may have benefited from it. According to Abba (1995), for example, large cost overruns on some major defense projects were foreseeable from contractor earned value reports but not recognized by program managers.

"Each criterion addresses a major principle necessary for effective management of large, flexibly priced defense projects."

There are several factors that contributed to the implementation problem (e.g., a lack of industry ownership, inadequate training, and an awkward technical jargon). A major factor was a failure in the early years to make the earned value process the responsibility of program managers and contractors. Based on a two-year review of the DoD's earned value management process, the GAO (1997) concluded that while the process was intended to serve the needs of several user groups, financial personnel managed the process. It was natural for this group to focus on their oversight responsibilities and stress criteria compliance. But it was

also natural for other user groups, including the program managers, to perceive earned value as a purely financial reporting requirement. According to the DoD, "the needs of the program manager were often not met when EVMS were viewed primarily as a financial reporting system" (GAO, 1997, p. 29).

Through the years, the criteria implementation problem has prompted studies that addressed either the benefits or the costs of the earned value management process. In general, studies that focused on benefits concluded that earned value and the criteria concept were sound, while those focused on cost reported the cost of compliance to be relatively small, ranging from less than one to five percent of contract cost. I found no study that directly compared benefits with costs, possibly because the benefits are largely nonquantifiable. Clearly, any study that focuses on only one side of a cost-benefit issue may be misleading.

"I found no study that directly compared benefits with costs, possibly because the benefits are largely nonquantifiable."

Regardless of the focus, nearly all of the studies are unpublished, thus contributing to the difficulty of comparing costs with benefits. My purpose is to remedy this problem by providing a summary of all I have found. I have compiled and reviewed most of the cost and benefit studies related to earned value. The results of this survey follow, as does a conceptual framework for comparing the costs and benefits of the EVM process.

THE COSTS OF THE EVM PROCESS

Most of the cost studies reviewed appropriately focus on the incremental cost of EVMS compliance and reporting. The "normal" costs of operating a management control system are not considered relevant because they would be incurred in the absence of any requirement for an earned value management system (DoD, 1987, p. viii).

COOPERS & LYBRAND/TASC

The most recent study of this kind, "The DoD Regulatory Cost Premium: A Quantitative Assessment," was conducted jointly by Coopers & Lybrand and TASC (C&L/TASC) under the auspices of the Under Secretary of Defense for Acquisition and Technology (1994). Its purpose was to estimate the industry cost of DoD regulation and oversight, including the regulatory requirement for EVMS. It did not include the DoD's direct oversight costs (e.g., government auditors). Based on an analysis of 10 contractor facilities, activity based costing was used to report an average regulatory cost premium of 18 percent of value-added costs.[1] The cost of EVMS ranked third among the top 10 cost drivers, and was estimated to be about 0.9 percent of the value-added costs. For example, in a graph depicting value-added costs, C&L/TASC indicate that material purchases are about 40 percent of the cost of a contract (p. 4a).[2] Thus, on a $100 million contract, $60 million (60 percent) would be value-added, $10.8 million (18 percent of $60 million) would be the regulatory premium and $0.54 million (0.9 percent of $60 million) would be the regulatory cost of EVMS to industry.

Most of the EVMS costs were in the areas of engineering and program management (65 percent), and finance (25 percent). Program managers are responsible for the entire management control system. Engineers are typically responsible for variance analysis and reporting. Finance personnel are typically required to ensure compliance with the EVMS criteria. A DoD working group that investigated these costs reported that most of them (two-thirds to three-fourths) were unnecessary and not required by criteria (DoD, 1997, pp. 8–9). An example is preparing written variance reports at detailed levels in the work breakdown structure, termed "control accounts." Although the criteria do not require a written variance analysis for each control account, government review teams came to expect them as tangible evidence of criteria compliance. Contractors with written variance reports were more likely to be found compliant than contractors without written variance reports. Eventually, a written variance report for every control account became an unwritten rule. Other examples of non-value-added activities that came be to expected for criteria compliance are provide by Abba (1997, p. 3).

Clearly, the 0.9 percent EVMS cost premium is only a rough estimate. The cost premium would be greater if the direct government costs were included. The premium would be smaller if the activities not required by the criteria were eliminated. In addition, C&L/TASC warn against generalizing the results of their study (p. 3). The sample was nonrandom and only 2 of the 10 sites had contracts subject to EVMS criteria. Further, the results cannot be independently verified because the data are proprietary. In general, C&L/TASC concluded that the contractors viewed EVMS positively, but that it was costly to implement (p. 22):

> All contractors subject to C/SCSC (EVMS criteria) agree that, as currently required by DoD, cost-schedule reporting is too detailed, repetitive, and voluminous to be used effectively as a management tool by either the government or industry, and that the requirement may in fact undermine program performance by diverting the time and attention of the company program manager.

OTHER COST STUDIES

Lampkin (1992) reviewed five studies that estimate the marginal cost of implementing and maintaining a criteria-complaint EVMS (Table 1).[3] The cost range is expressed as a percentage of contract cost. The first three estimates are based on opinion surveys of industry or DoD experts. The MITRE estimate pertains to Air Force software development contract only. Decision Planning Corporation (1992) uses a cost-estimating model that assumes a generic, 3-year research and development contract of $75M. Humphreys and Associates distinguish between nonrecurring and recurring costs. Nonrecurring costs pertain to implementing a criteria-compliant system for the first time, and range from 2.5 to 4.0 percent. Recurring costs pertain to maintaining criteria-compliance, and

"Eventually, a written variance report for every control account became an unwritten rule."

Table 1.
The Marginal Cost of EVMS Criteria
(Percent of Contrast Cost)

Author (Year)	Source of Estimate	Cost Range (%)
Kouts (1978)	Survey of industry	0.5 to 5
MITRE Corp. (1982)	Survey of industry	0.1 to 0.2
DoD IG (1984)	Survey of DoD experts	5.0
Decision Planning Corp. (1992)	Industry cost estimation model	0.6 to 1.0
Humphreys and Associates (1992)	Consultant experience	0.5 to 4.0
Lampkin (1992)	Average of five studies above	0.4 to 1.63

Lampkin (1992)

range from 0.5 to 1.5 percent. The final row in the table is an average of these estimates, also reported by Lampkin (p. 37).[4]

Unnecessary Cost Drivers

Survey and interview research indicate that at least some of the cost of EVMS is unnecessary and due to an over-implementation of the criteria (Table 2). Examples include lengthy "system descriptions" of EVMS, written variance analysis at the control account level, and over-specified work breakdown structures. The National Security Industrial Association (NSIA) (1980, p. 17) estimated the number of pages required to achieve and maintain criteria-compliance for the industry to be 32.8 million pages annually. Based on a survey and interviews, Arthur D. Little (1983, 1984) concluded that EVMS was a good approach to controlling contract performance, but that there was room for improvement (p. I–3).

Prompted by this conclusion, the DoD and NSIA formed a total quality management team to review EVMS in 1989. One of its purposes was to determine where there may be excessive cost and to what extent the cost could be reduced. The team concluded that there are excesses in EVMS implementation and reporting that result in unnecessary cost (p. 3.9.7).

EVMS Reforms and Cost Reduction

The sensational cancellation of the Navy's A–12 program (Beach, 1990) and a subsequent DoD audit report (1993) were additional catalysts for reform. To promote a program management orientation, the DoD policy-making body for EVMS was shifted to an executive steering group with representatives from the services, acquisition executives, and the Defense Contract Management Command (DCMC) in 1995.[5] To refocus program management attention to the information in earned value reports, compliance responsibility was transferred from the military services to DCMC in 1996. Finally, the DoD criteria used since 1967 were replaced with industry standards in 1996, and the possibility for industry

Table 2.
Other Studies Related to the Cost of EVMS

Author (Year)	Research Method (Sample Size)	Cost Drivers Related to Over-Implementation
NSIA (1980)	Opinion survey (74 contractors	Excessive documentation
A.D. Little (1984)	Interview (56 managers)	Excessive levels of detail in the WBS
DoD/NSIA (1991)	Interview (250 mangers)	Written variance analysis reports

self-certification was offered (Christle, 1994).

Removing unnecessary requirements related to EVMS will likely reduce but not eliminate the marginal cost. The NSIA estimated industry-wide savings from reforming EVMS could reach over one billion dollars annually (Christle, 1996). A DoD working group estimates the EVMS regulatory premium can be reduced by one third or 0.3 percent of value-added costs (DoD, 1997). Thus, two-thirds of the EVMS regulatory premium or 0.6 percent will remain.

The Benefits of the EVM Process

None of the marginal cost studies describes the marginal benefits of EVMS, perhaps because the benefits are difficult to quantify. Accordingly, most benefit studies I review here are qualitative assessments. However, to the extent that the criteria help a company use or continue to use the management principles required by the criteria, I believe the marginal benefits of the criteria are greater than zero.

The Legacy of EVMS

The full application of the criteria is appropriate for large, cost-reimbursable contracts where the government bears the cost risk. For such contracts, the management discipline described by the criteria is essential. The box on following page is an abbreviated list of EVMS benefits, described by Fleming and Koppelman as the legacy of using the criteria on government contracts for three decades (1996, p.22). Note that they do not separate the benefits of earned value data from the benefits of the criteria, perhaps because the reliability of data depends on the disciplined application of the management practices described by the criteria.

Benefit 1. Although the criteria do not require an external report, managing with one system while reporting from another is neither efficient nor effective. The criteria concept encourages the company to use its own internal management control systems, provided those systems meet the management standards described by the criteria.

Benefit 2. The criteria require that all the authorized work and related resources are defined and integrated using a product-oriented work breakdown structure.

Ten Benefits of EVMS

1. It is a single management control system that provides reliable data.
2. It integrates work, schedule, and cost using a work breakdown structure.
3. The associated database of completed projects is useful for comparative analysis.
4. The cumulative cost performance index (CPI) provides an early warning signal.
5. The schedule performance index provides an early warning signal.
6. The CPI is a predictor for the final cost of the project.
7. It uses an index-based method to forecast the final cost of the project.
8. The "to-complete" performance index allows evaluation of the forecasted final cost.
9. The periodic (e.g., weekly or monthly) CPI is a benchmark.
10. The management by exception principle can reduce information overload.

For a company that has managed by functional areas only (e.g., engineering, manufacturing, accounting), the product orientation can help organize and coordinate the contributions of each area, and ensure that work, schedule, and cost are properly integrated.

Benefit 3. The consistent reporting of criteria-compliant projects for over 30 years has resulted in a database useful for comparative analysis analysts have used this database to create important insights for managers. For example, a comparative analysis of the cost performance of similar aircraft was compelling evidence that the Navy's A–12 project was out of control (Beach, 1990).

Benefit 4. The cumulative cost performance index (CPI), defined as the earned value to-date divided by the cost to-date, has been shown to stabilize to within 10 percent by the 20 percent completion point for most defense acquisition contracts. In most cases the cumulative CPI only worsens (Christensen and Heise, 1993). Among other things, this indicates that cost management must occur early to be effective.

Benefit 5. The schedule performance index (SPI), defined as earned value divided by planned value, is useful for identifying schedule problems, especially when used with critical path information (Fleming and Koppelman, 1996, p. 5). Because schedule problems are often resolved by additional spending, an adverse SPI is also predictive of later cost problems. The criteria recommend that all the work is scheduled and traceable from the master program level to the detailed levels. Consistent with the criteria concept, no specific scheduling system is required.

Benefit 6. The cumulative CPI is also useful for determining a reasonable lower

limit for the estimated final cost of a contract, termed the estimate at completion (EAC) (Christensen, 1996). A lower bound is useful for planning and control purposes. The criteria recommend that the estimate be evaluated regularly.

Benefit 7. It has been shown that the SPI and CPI can be combined to estimate a reliable upper bound to the EAC (Christensen, 1996). When combined with the CPI-based lower bound, a "most likely" range of EACs is determined. When the contractor's EAC is outside this range, there may be a problem with the contractor's estimation system.

Benefit 8. Another earned value index, the to-complete performance index (TCPI), is useful for evaluating the reasonableness of the contractor's EAC or other financial goals (Christensen, 1994). The TCPI is the ratio of the remaining work to the remaining financial resources. It indicates the level of performance that the contractor must achieve to reach a financial goal. Thus, this earned value metric can help the manager assess the reasonableness of critical financial goals, such as completing the remaining work within the targeted cost.

Benefit 9. While cumulative performance indices are useful for predicting trends at summary levels in the work breakdown structure (WBS), weekly or monthly CPIs are useful for cost performance trends at the detailed levels of the WBS (Fleming and Koppelman, p. 28). The criteria recommend an analysis of these and all other metrics at the frequency and level needed by management for effective control (DoD, 1996).

Benefit 10. By directing management attention to only the most critical problems, information overload can be reduced. Although not always implemented properly, the criteria encourage variance thresholds and tailoring to reduce the potential for overload.

Other benefit studies. Survey research shows that most managers agree that EVMS has benefits (NSIA, 1980; Little, 1983 and 1984; DoD/NSIA, 1991). Based on a survey of 534 managers, for example, more than 70 percent agree that "a major benefit of the criteria is more thorough planning than would otherwise be accomplished," and that EVMS is "effective in helping managers control contract performance" (Little, 1983, 0. III–3). Government audits of the EVMS process have not challenged this perception (DoD, 1993; GAO, 1997). For example, the GAO (1997) reports that the earned value concept is "recognized as a sound way to measure progress on major acquisition programs" (p. 3).

"Survey research shows that most managers agree that EVMS has benefits."

SYNTHESIS

Figure 1 identifies qualitative characteristics that a report should possess to be useful for decision making.[6] I believe it is a useful conceptual framework for comparing the costs and benefits of EVMS. The output of the EVMS process is the earned value report. To be useful for decision making, the report should have relevance and reliability.

To be relevant, the report should have predictive value, feedback value, and be timely. Many of the marginal benefits of

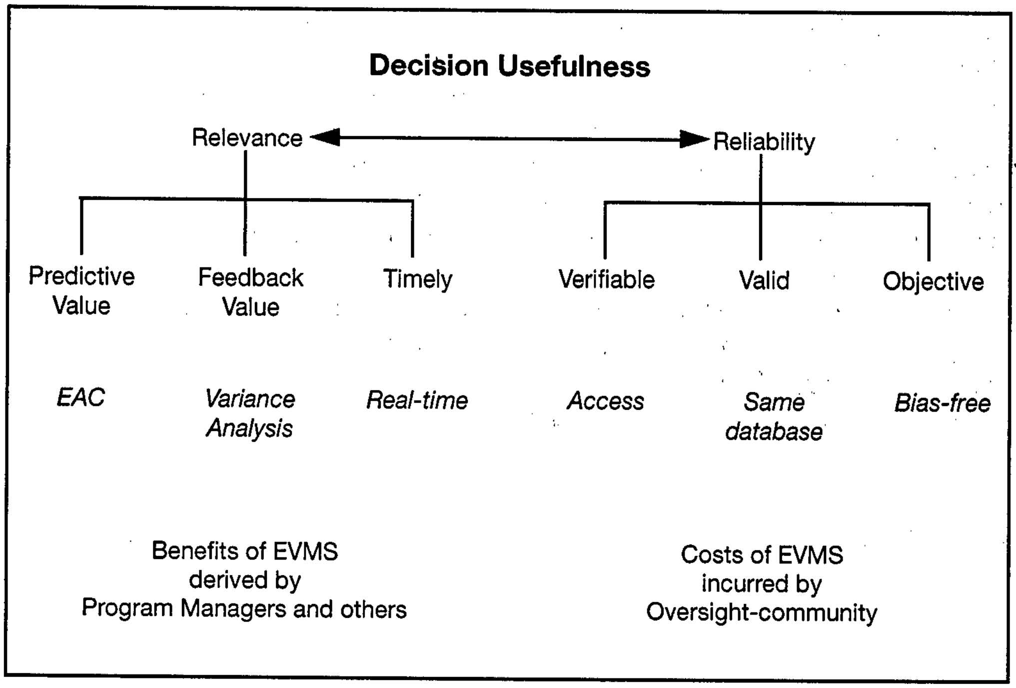


Figure 1. The Costs and Benefits of EVMS

EVMS pertain to these characteristics. The benefit studies indicate that managers and oversight personnel find the EAC and the variance information useful, if not timely. Surveys indicate some dissatisfaction with the report being too late (DoD/NSIA, 1991); however, recent improvements in computer technology and software have made real-time access to contractor databases achievable (GAO, 1997).

To be reliable, the report should be verifiable, valid, and objective. Oversight personnel are primarily concerned with reliability. The marginal costs of EVMS arise primarily from the need for reliability. The government needs access to contractor data verify its accuracy. The government also needs assurance that the contractor is reporting and managing from the same database. Finally, because the criteria are applied primarily to cost-reimbursable contracts, the cost data must be objective.

Achieving these qualitative characteristics is not easy. The double-headed arrow between relevance and reliability suggests a tradeoff. A report may not be timely, for example, if every number must be verified. The GAO (1997) observed that a delicate balance exists between managers (needing relevance) and the oversight community (needing reliability), and concluded that because the oversight community managed the EVMS process, the need for reliability was stressed over the need for relevance.

However, EVMS reforms have restored the balance. The marginal cost of EVMS has decreased, while the marginal benefits have increased. As the unnecessary activities related to implementing the criteria (e.g., written variance reporting)

are eliminated, the DoD estimated a one-third reduction in the EVMS cost premium. With the shift in ownership and management responsibilities to program managers, the value of the earned value reports should be easier for program managers to recognize (Abba, 1997).

Ultimately, the decision of whether the marginal benefits of EVMS exceed the marginal cost is subjective. Perhaps the most compelling evidence that benefits exceed the costs is the astonishing increase to earned value outside the DoD by other agencies, commercial companies, and other countries (Abba, 1997; GAO, 1997). After decades of assertions that EVMS is too expensive and only appropriate for DoD projects, earned value is recognized more than ever as a necessary and effective management tool for projects of any size and risk. The key is the proper application of EVMS (Fleming and Koppelman, 1996).

ENDNOTES

1. Value-added costs are the costs to convert raw material to a finished product. Total costs were not used as the base to determine the regulatory premium because a prime contractor's material purchases are "to a great extent the value-added costs of its subcontractors and suppliers." Using total costs in the denominator would double-count material costs and understate the regulatory cost impact (Coopers & Lybrand and TASC, 1994, p. 4).

2. C&L/TASC did not indicate that 40 percent was based on the actual cost data from the sample. It may simply be an example used to explain the meaning of value-added costs.

3. Unfortunately, we could not locate most of these studies to evaluate the methodology.

4. C&L/TASC used value-added costs to determine the 0.9 percent cost premium of EVMS. If the percentages in Table 1 were also based on value-added cost, they would be larger. For example, if the average value-added cost is 60 percent of contract cost, the range reported by Lampkin would be 0.67 percent to 2.71 percent.

5. As the government's on-site representative at the contractor's facility, DCMC provided DoD with assessments of the contractor's performance.

6. We have adapted this from a conceptual framework used by the Financial Accounting Standards Board (1980).

References

Abba, W. (1995, October). *Earned value management rediscovered!* Washington, DC: Office of the Under Secretary of Defense for Acquisition.

Abba, W. (1997, January-February). Earned value management—Reconciling government and commercial practices. *Program Manager 26,* 58–69.

Beach, C. P. Jr. (1990, November). *A–12 administrative inquiry* (Report to the Secretary of the Navy). Washington, DC: Department of the Navy.

Christensen, D. S. (1994). Using performance indices to evaluate the estimate at completion. *Journal of Cost Analysis,* 17–24.

Christensen, D. S. (1996, Spring). Project advocacy and the estimate at completion problem. *Journal of Cost Analysis,* 61–72.

Christensen, D. S., & Heise, S. (1993, Spring). Cost performance index stability. *National Contract Management Journal 25,* 7–15.

Christle, G. (1994). *Implementation of earned value—A model program approach.* Washington, DC: Office of the Under Secretary of Defense for Acquisition.

Christle, G. (1996). *Earned value management—The cost/schedule control systems criteria and the DoD regulatory premium: A call to action.* Washington, DC: Office of the Under Secretary of Defense for Acquisition.

Coopers & Lybrand and TASC. (1994). *The DoD regulatory cost premium: A quantitative assessment.* Washington, DC

Decision Planning Corporation. (1992). *The cost of the criteria.* Costa Mesa, CA: Author.

Department of Defense. (1987). *C/SCSC white paper: DoD joint implementation guide.* Washington, DC: Author.

Department of Defense. (1993). *Use of contractor cost and schedule system data* (Audit Report 93-067). Arlington, VA: Office of the Inspector General.

Department of Defense. (1996). *DoD 5000.2–R: Management procedures for major defense acquisition programs.* Washington, DC: Author.

Department of Defense. (1997). *Cost driver No. 3—Cost/schedule control system criteria (C/SCSC). DoD updated compendium of office of primary responsibility reports.* Washington, DC: DoD Regulatory Cost Premium Working Group.

Department of Defense and National Security Industrial Association. (1991). *Joint DoD/industry total quality management team report for program management on the cost/schedule management process.* Washington, DC: Author.

Financial Accounting Standards Board. (1980). *Qualitative characteristics of accounting information. Statement of financial accounting concepts* (No. 2). Norwalk, CT: Author.

Fleming, Q. M. & Koppelman, J. M. (1996). *Earned value project management.* Upper Darby, PA: Project Management Institute.

General Accounting Office. (1996). *Efforts to reduce the cost to manage and oversee DoD contracts* (NSIAD 96-106). Washington, DC: Author.

General Accounting Office. (1997). *Significant changes in DoD's earned value management process* (NSIAD 97-108). Washington, DC.

Lampkin, E. D. (1992). *The marginal cost and practicality of cost/schedule control systems criteria implementation. Aeronautical systems center.* Dayton, OH: Wright-Patterson Air Force Base.

Little, A. D., Inc. (1983 and 1984). *Survey relating to the implementation of cost/schedule control systems criteria within the Department of Defense. A report to the Assistant Secretary of Defense (Comptroller). Phases I and II.* Author.

National Security Industrial Association (NSIA). (1980). *Cost schedule systems compendium.* Washington, DC: Author.

OPINION

A CASE STUDY FOR THE SYSTEMS APPROACH FOR DEVELOPING CURRICULA

"DON'T THROW OUT THE BABY WITH THE BATH WATER"

Dr. Anthony A. Scafati

Instructional systems design (ISD) is a systematic model used to plan, design, develop, and evaluate training. The Defense Acquisition University consortium uses ISD to develop and revise curriculum. If we agree that all learning manifests itself by observable behaviors, then we can measure the progress and effectiveness of training. The author urges that ISD is especially effective in developing learning experiences that meet the needs of acquisition community. It does not hamper "academic freedom," but instead provides consistency and performance standards—both necessary for the move to distance learning and computer-based instruction.

Ruth Colvin Clark (1989, p. 3) defines instructional systems design (ISD) as a "...systematic model used to plan, design, develop, and evaluate training." There are many ISD models in existence today, but all have a variation of the following characteristics. They incorporate:

- a needs analysis;
- a task analysis;
- a definition of learning objectives;
- the development of an assessment plan;
- the development of learning material;

- a plan to try out with revision (pilot); and

- the implementation of the final product (Clark, 1989).

The systems approach models are the result of more than 25 years of research in the learning process (Dick & Carey, 1990). It is used throughout industry and government and in academia. It is not the only way to develop curriculum, but it is a proven and effective model. The Defense Acquisition University (DAU) and, consequently, the DAU consortium schools, use their version of ISD to develop and revise their curriculum. The latest guidance concerning the DAU methodology is found in the "Defense Acquisition Guide for Curriculum Development, Delivery, and Evaluation" (November, 1997), which can be found on the DAU Home Page (http:\\www.acq.osd.mil/dau).

The systems approach to designing curriculum has many names: Instructional Systems Design (MilStd 1379D)—the old military standard, The Critical Events Model (Nadler, 1982), Systematic Design of Instruction (Dick & Carey, 1990), the DAU Guide for Curriculum Development, Delivery, and Evaluations (November, 1997), and a host of others. They all are based on a common belief that all learning manifests itself by observable behaviors in the psychomotor, cognitive, or affective domains. And if there is any credence to the metaphor that learning is a journey, then with ISD we can describe the end state and measure our progress and effectiveness in getting there. If we don't take the time to determine precisely where we are going, we will not be able to determine the effectiveness of our process. And as the saying goes, " Any road will do if you don't know where you are going."

The ISD model is especially effective in developing learning experiences that meet the needs of a well-defined target audience and other stakeholders (such as our Functional Boards). It can do so while maintaining currency and consistency in a rapidly changing environment, such as acquisition reform.

For the past year, the Defense Systems Management College (DSMC), as well as the other DAU Consortium Schools, has performed in a yeoman fashion the reengineering of all of its major courses.

The process the schools employed was the DAU ISD model. During this process, the schools experienced a considerable amount of oversight from the Functional Boards and DAU. For many in the consortium schools, this has been a traumatic experience. ISD in the best of

Anthony A. Scafati, Ph.D., is the past chair of the Education Department at the Defense Systems Management College (DSMC). He is presently the director of DSMC's professional development for faculty and staff. He holds a B.S. degree in biology, an M.Ed. degree in counselor education from the University of Virginia, and an Ed.D. degree in higher education administration/human resources management from The George Washington University. He served as DSMC educational specialist for the redesign of ACQ 201 and the revised Advanced Program Managers Course. Scafati is an adjunct professor at the National-Louis University, teaching students in the master of science, management curriculum.

circumstances is a labor-intensive process requiring between 60 to 100 hours of development time for every hour in the classroom. This development overhead rapidly increases as we move to the technology-based education (TBE) delivery media.

For the novice, the gains in quality learning by using this process are not immediately apparent. It is especially difficult to see the worth of this effort when the immediate results of the first offering are not showing the gains in student satisfaction that was and should be expected. Never fear; ISD is an iterative process and is expected to be less than perfect on the first offering. The truth be known, it is never finished. The final step in the ISD process is to evaluate the process (note that I did not say "the student") and change the process when indicated. If you make a conscious decision to forego the "try out with revision" step (also known as a pilot), then you can expect even greater discrepancies.

ISD, as an engineering process, appears to have little flexibility. Some may view the process as a loss of academic freedom. Academic freedom, as defined by Brubacher & Rudy (1976, p. 308) is... "the right of a professor to follow an argument whither so ever it may lead either in his research or in his teaching...." Another definition, espoused by *Webster's II* (1984, p. 69), is "...without interference, as from school or public officials." These definitions are the quintessential essence of higher education ,where ideas are allowed to be discussed and aired without fear of retribution by higher authority. Academic freedom at its core assures First Amendment rights and fosters research, creativity, and learning by allowing the full range of the exploration of ideas. Neither *Webster's* nor Brubacher & Rudy's definition of academic freedom, however, exempts a professor from meeting the specific and implicit objectives of the course or lesson, as articulated in the performance outcomes and the terminal learning objectives (TLOs). It is an institution's prerogative to determine objectives. One implicitly agrees to follow this direction when hired.

One of the primary strengths of the systems approach to developing curriculum is defining clear and measurable objectives. By clearly defining the objectives and the assessment processes of a course or lesson, ISD provides a consistent and repeatable educational experience. Consistency is the sense that any number of students can be exposed to the process and be assured that they will attain mastery of the subject. Constructed properly, this consistency is assured by designing fidelity into the lesson or course from a test question up to and including the performance outcome. In simpler terms, it means that each question on a test, and each assessment opportunity, is designed to address the behaviors expressed in the performance outcome with a high level of correlation. This characteristic is extremely important to an institution that needs to educate large numbers of students to meet an acceptable performance standard. The consortium schools are such institutions.

"One of the primary strengths of the systems a pproach to developing curriculum is defining clear and measurable objectives."

Another concern of the faculty is the expenditure of time needed to design

courses using the systematic approach models. Earlier I stated that, for planning purposes , an expenditure of 60 to 100 hours of development time is required for each hour in the classroom. In my experience these hours increase dramatically when we are developing or converting courses to TBE. Time is a scarce and critical commodity, especially as the demand for professor time is on the rise while personnel resources are being reduced.

What I am concerned about is the possibility that the pressures related to teaching preparation, teaching, and curriculum development are so great that the true value of what the schools have accomplished will not be understood by the faculty. In this environment there is a possibility that the ISD process will be regarded as noxious and with little return on investment. The result may be the paying of lip service to the process or worse yet, returning to the former "intuitive" curriculum design method—so long practiced here and in higher education in general. (By "intuitive" I mean each individual professor selecting what is important to learn, resulting in the lack of consistency among and between professors of the same subject and over time.) If this occurred, it would be a disservice to the schools and to all their customers.

"What I am concerned about is the possibility that the pressures related to teaching preparation, teaching, and curriculum development are so great that the true value of what the schools have accomplished will not be understood by the faculty."

Intuitive curriculum development has found a legitimate place in traditional higher education. Higher education, (except for some technical curricula, such as nursing), is not responsible for educating students for a specific workplace with specific expected behaviors. Therefore, considering the vast amount of knowledge accumulated in any traditional field, such as liberal arts or science, the selection of the outcomes is usually prescribed by the individual professor. Those professors cannot measure their educational effectiveness against a set of competencies or performance measures, because those competencies and performance measures do not exist. Who, for example, knows where student "X" is going to work when he or she graduates with a B.S. degree from Anyplace University? The graduates themselves do not know until the final hour, if then. Traditional higher education measures student against student. The students compete for a grade and are not encouraged to engage in cooperative learning. In acquisition management team problem solving, integrated product teams (for example) are not only allowed, they are mandated. The schools teaching acquisition management must simulate the work environment; therefore learning, like work, is cooperative. Students should not be measured against each other but assessed against a performance standard.

We in the Consortium Schools know the specific workplace where our graduates are going and how they will be required to perform. Therefore, our course objectives—performance standards if you will—cease to be the prerogative of the individual professor but become the natural outcome of a systematic analysis of the student and institutional needs.

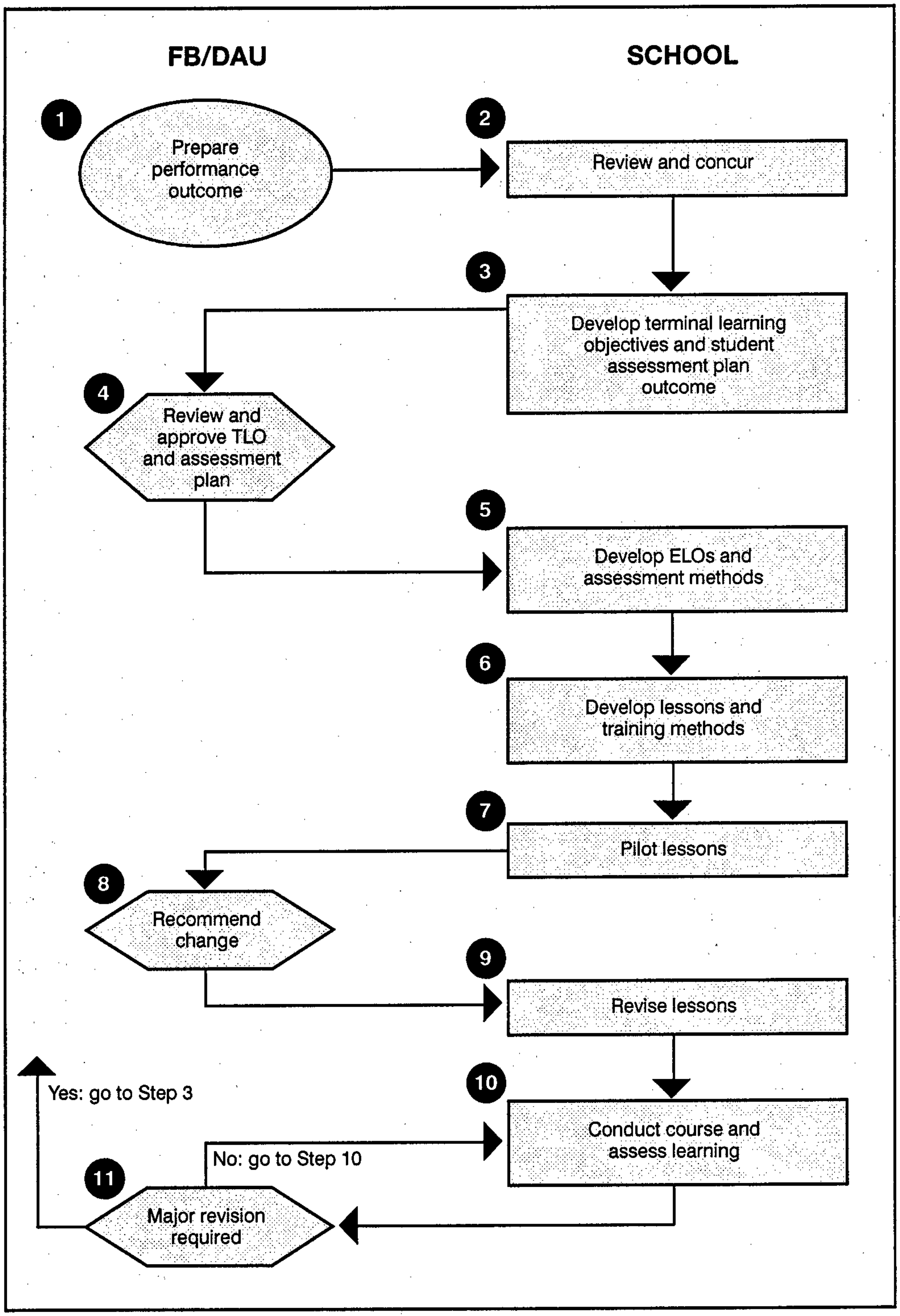


Figure 1. The Systems Approach to Developing Curriculum

Please understand that the ISD process only requires that the student reaches minimum behaviors to perform adequately in the field through the educational process. This does not prohibit the professor from facilitating learning to the extent a student's prior experiences and time allows. Additionally, the ISD process will provide one way of teaching a course via the Instructor Guide (IG). The IG should never be the *only* way to teach. Therefore an individual professor maintains the right to select the media and to go beyond the minimum objectives.

The school's responsibility is to take the institutional needs as defined by the Functional Boards (Performance Outcomes), and design a course that contains terminal learning objectives (TLOs) and a selection of enabling learning objectives (ELOs), a student and course assessment plan, and a delivery system, which meets the level of learning desired within the constraints of time and resources. The delivery and assessment areas are most appropriate for individual professors to exercise academic freedom and creativity in making the learning experience an adult and creative experience for the student. Each offering of a class need not be a carbon copy of the others. The professors' individual creative strengths and specific needs of their students drive the methodology. The only caveat expressed is that when a professor deviates from a course design, his or her students must fare as well as others, as measured by standard assessment tools.

"The delivery and assessment areas are most appropriate for individual professors to exercise academic freedom and creativity in making the learning experience an adult and creative experience for the student."

I believe that if we continue to follow a systems approach design philosophy and exploit the inexhaustible talent of the Consortium Schools faculty, we can meet the spirit and the letter of the DAU guidance and encourage creativity while bringing a dynamic and challenging learning climate to our students Figure 1 is a notional flow of a typical systems approach to designing curricula.

Let us remember that what we have done in this last year, as far as curriculum design is concerned, is to utilize with some degree of efficiency what has long been proven by educators and trainers alike to be an effective methodology to design and improve curriculum. It is not the only way—but it is a proven way. Let us not be discouraged by a lack of empirical data to prove our success. That will come from the assessment data gathered from students, faculty, alumni, and their supervisors. Let us not fail to realize its benefits to us and, more important, to those whom we are most responsible: the students. Teachers are ultimately responsible for facilitating the learning environment. We have an approved and a provable design methodology. Let's *not* throw the baby out with the bath water!

References

Brubacher, J. S., & Rudy, W. (1976). *Higher education in transition* (3rd ed.). New York: Harper & Row.

Dick, W., & Carey, L. (1990). *The systems design of instruction* (3rd ed). Tallahassee, FL: Harper Collins.

Defense Acquisition University. (1997, November). *Guide to curriculum development, delivery and evaluation. Fort Belvoir, VA: Author.*

Clark, R. C. (1989). Developing technical training. Beverly, MA: Addison-Wesley.

Nadler, L. (1982). *Designing training programs, the critical events model.* Reading, MA: Addison-Wesley.

Webster's II new riverside university dictionary. (1984). Boston, MA: The Riverside Publishing Company.

ACQUISITION REVIEW QUARTERLY GUIDELINES FOR CONTRIBUTORS

The *Acquisition Review Quarterly (ARQ)* is a scholarly peer-reviewed journal published by the Defense Acquisition University. All submissions receive a masked review to ensure impartial evaluation.

SUBMISSIONS

Submissions are welcomed from anyone involved in the Defense acquisition process. Defense acquisition is defined as the conceptualization, initiation, design, development, test, contracting, production, deployment, logistic support, modification, and disposal of weapons and other systems, supplies, or services to satisfy Defense Department needs, or intended for use in support of military missions.

RESEARCH ARTICLES

Manuscripts should reflect research or empirically-supported experience in one or more of the aforementioned areas of acquisition. Research or tutorial articles should not exceed 4,500 words. Opinion pieces should be limited to 1,500 words.

We publish Defense Acquisition research articles that involve systemic inquiry into a significant research question. The article must produce a new or revised theory of interest to the acquisition community. You must use a reliable, valid instrument to provide your measured outcomes.

MANUSCRIPT SECTIONS

The introduction should state the purpose of the article and concisely summarize the rationale for the undertaking.

The methods section should include a detailed methodology that clearly describes work performed. Although it is appropriate to refer to previous publications in this section, the author should provide enough information so that the experienced reader need not read earlier works to gain understanding of the methodology.

The results section should concisely summarize findings of the research and follow the train of thought established in the methods section. This section should not refer to previous publications, but should be devoted solely to the current findings of the author.

The discussion section should emphasize the major findings of the study and its significance. Information presented in the aforementioned sections should not be repeated.

RESEARCH CONSIDERATIONS

Contributors should also consider the following questions in reviewing their research-based articles prior to submission:

- Is the research question significant?
- Are research instruments reliable and valid?
- Are outcomes measured in a way clearly related to the variables under study?
- Does the research design fully and unambiguously test the hypothesis?
- Did you build needed controls into the study?

Contributors of research-based submissions are also reminded they should share any materials and methodology necessary to verify their conclusions.

CRITERIA FOR TUTORIALS

Tutorials should provide special instruction or knowledge relevant to an area of defense acquisition to inform the Defense Acquisition Workforce.

Topics for submissions should rely on or be derived from observation or experiment, rather than theory. The submission should provide knowledge in a particular area for a particular purpose.

OPINION CRITERIA

Opinion articles should reflect judgments based on the special knowledge of the expert. Opinion articles should be based on observable phenomena and presented in a factual manner; that is, submissions should imply detachment. The observation and judgment should not reflect the author's personal feelings or thoughts. Nevertheless, opinion pieces should clearly express a fresh point of view, rather than negatively criticize the view of another previous author.

MANUSCRIPT STYLE

We will require you to recast your last version of the manuscript, especially citations (e.g., footnotes or endnotes) into the format required in two specific style manuals. The ARQ follows the author (date) form of citation. We expect you to use the Publication Manual of the American Psychological Association (4th Edition), and the Chicago Manual of Style (14th Edition). The ARQ follows the author (date) form of citation.

Contributors are encouraged to seek the advice of a reference librarian in completing citations of government documents. Standard formulas of citations may give only incomplete information in reference to government works. Helpful guidance is also available in Garner, D.L. and Smith, D.H., 1993, The Complete Guide to Citing Government Documents: A Manual for Writers and Librarians (Rev. Ed.), Bethesda, MD: Congressional Information Service, Inc.

Copyright Information

The *ARQ* is a publication of the United States Government and as such is not copyrighted. Contributors of copyrighted works and copyright holders of works for hire are strongly encouraged to request that a copyright notification be placed on their published work as a safeguard against unintentional infringement. The work of federal employees undertaken as part of their official duties is not subject to copyright.

In citing the work of others, it is the contributor's responsibility to obtain permission from a copyright holder if the proposed use exceeds the fair use provisions of the law (see U.S. Government Printing Office, 1994, Circular 92: Copyright Law of the United States of America, p. 15, Washington, DC: Author). Contributors will be required to submit a copy of the written permission to the editor before publication.

Manuscript Format

Pages should be double-spaced and organized in the following order: title page, abstract, body, reference list, author's note (if any), and figures or tables. To ensure anonymity, each paper should be submitted with a separate page that includes the author(s)'s name(s) and complete address, and the paper should include the title, abstract, keywords, body, complete set of references, along with tables and figures at the end. Authors are reminded not to refer to themselves or to their own work directly in the paper. Figures or tables should not be inserted (or embedded, etc.) into the text, but segregated one to a page following the text. Articles must be printable within one issue and should not exceed 4,500 words for research or tutorials and 1,500 words for opinion pieces; articles will not be printed in parts or in a continuing series. If material is submitted on a computer diskette, each figure or table should be recorded in a separate, exportable file (i.e., a readable .eps file). For additional information on the preparation of figures or tables, see CBE Scientific Illustration Committee, 1988, Illustrating Science: Standards for Publication, Bethesda, MD: Council of Biology Editors, Inc. Please restructure briefing charts and slides to a look similar to those in previous issues of ARQ.

The author (or corresponding author in the case of multiple authorship) should attach to the manuscript a signed cover letter that provides the author's name, address, and telephone number (fax and Internet addresses are also appreciated). The letter should verify that the submission is an original product of the author; that it has not been published before; and that it is not under consideration by another publication. Details about the manuscript should also be included in this letter: for example, its title, word length, the need for copyright notification, the identification of copyrighted material for which permission must be obtained, a description of the computer application programs and file names used on enclosed diskettes, etc.

The letter, one copy of the printed manuscript, and any diskettes should be sturdily packaged and mailed to: Defense Systems Management College, Attn: DSMC Press (*ARQ*), 9820 Belvoir Road, Suite 3, Fort Belvoir, VA 22060-5565.

In most cases, the author will be notified that the submission has been received within 48 hours of its arrival. Following an initial review, submissions will be referred to referees and subsequent consideration by the *ARQ* Editorial Board.

Contributors may direct their questions to the Editor, *ARQ*, at the address shown above, by calling (703) 805-4290 (fax 805- 2917), or via the Internet at:

gonzalezd@dsmc.dsm.mil.

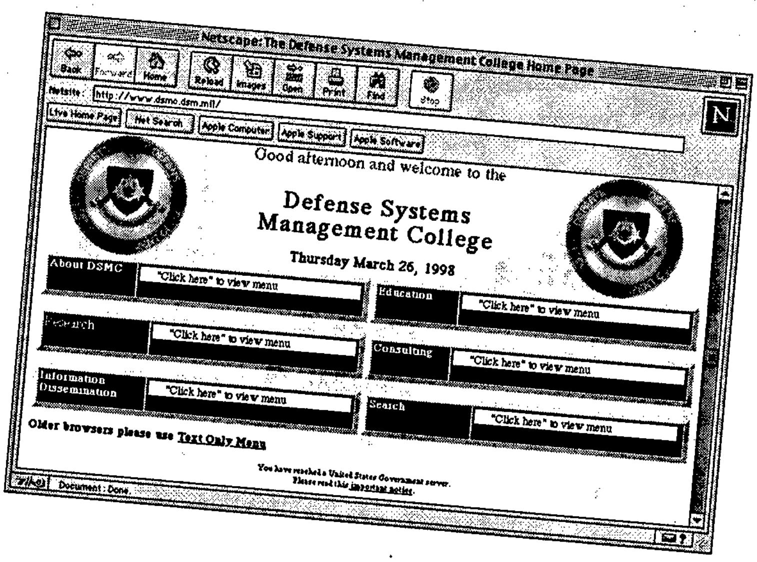
The DSMC Home Page can be accessed at:

http://www.dsmc.dsm.mil.

DSMC'S Home Page

http://www.dsmc.dsm.mil

Your Online Access to Acquisition Research, Consulting, Information, and Course Offerings



On DSMC Home Page Now...

About DSMC

- Commandant's Welcome
- DSMC Information
- Executive Institute
- DSMC Education
- General Student Information
- Getting to Ft. Belvoir
- News and Events

Research

- David D. Acker Library
- Acquisition Related Events
- Best Practices
- Lessons Learned
- Overview/Projects
- ROAR
- Information Dissemination
- Related Links
- Publications
- Services

Education

- Academic Programs Division
- Course Catalog
- Division of College Administration and Services (DCAS)
- Divisions/Faculty Departments
- DSMC Alumni
- DSMC Course List
- The Executive Program Manager's Course (EPMC)
- Access to the EPMC Intranet
- Learning Resource Center
- Program Management
- Regional Centers
- Registrar

Consulting

- The Cost Analysis Strategy Assessment (CASA) model
- Expertise List
- Management Deliberation Center (MDC)/Group Services
- Consulting Services

Now you can Search the DSMC Website and our on-line Publications!

The

ACQUISITION REVIEW QUARTERLY

Is Now Available

FREE

TO ALL SUBSCRIBERS

including
Executives and Officers
with
Government Agencies, Defense Industries,
Academic Institutions, Libraries,
and Research Centers
involved in
Defense Acquisition Management
and Reform Issues

Fax Subscription Requests to
Carrie Marshall
ARQ Subscription Manager
Defense Systems Management College
(703) 805-2917
DSN 655-2917